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WATER RESOURCES ACTIVITIES IN THE UNITED STATES. FLOODS AND FLOOD CONTROL

Select Committee on National Water Resources,
U. S. Senate

July 1960

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COMMITTEE PRINT NO. 15

WATER RESOURCES ACTIVITIES IN THE UNITED STATES

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FLOODS AND FLOOD CONTROL

SELECT COMMITTEE ON NATIONAL WATER RESOURCES
UNITED STATES SENATE
PURSUANT TO
S. Res. 48
EIGHTY-SIXTH CONGRESS

JULY 1960

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STATEMENT BY THE CHAIRMAN

JULY 27, 1960.

To the Members of the Select Committee on National Water Resources:

Among other things, Senate Resolution 48 directs the committee to consider appropriate provisions for flood control along with development of the Nation's water resources to meet the needs of population, agriculture, and industry. As a means of helping the committee to meet its responsibilities in the flood control field, I asked the Department of the Army to have the Corps of Engineers prepare a report on flood control in the United States covering the extent and character of past and present flood control programs and needed additional programs.

The report submitted to the committee in response to my request discusses the flood problems of the United States, and tabulates past and expected future damages by river basins. The historical and legislative background of Federal efforts in the flood control field is given, and possible solutions for flood problems are discussed in the light of the fact that it appears that overall flood damages appear to be increasing more rapidly than it has been possible to reduce them by construction of control works.

The Corps of Engineers points out that the estimated Federal cost of its present authorized flood control program is about $8.8 billion. Through fiscal year 1960, about $3.8 billion has been appropriated, leaving a requirement for about $5 billion to complete the program. When completed, the existing and authorized program would provide 127 million acre-feet of flood control storage in 340 reservoirs, 12,000 miles of levees and floodwalls, and 10,700 miles of channel improvement.

The corps has prepared an inventory of works and projects needed to prevent flood damages in the foreseeable future through 1980. The report suggests that about 6 billion dollars' worth of projects in addition to those now authorized will be required for river flood control plus about $500 million for projects to protect against hurricane-driven coastal floods. These additions to the program include about 64 million acre-feet of flood control storage in reservoirs, 4,300 miles of levees and floodwalls, and 5,900 miles of channel improvements. The report shows that substantial increases in present expenditures for flood control works would be required for the program to keep ahead of the potential damages which are increasing because of encroachment on flood plains.

The Corps of Engineers suggests that the Federal flood control program could be improved by expanding the present program to encompass provisions designed to encourage regulation of the use of the flood plains and to preserve important reservoir sites for future use. Suggestions are also made for more effective coordination of all activities affecting the development, use, and conservation of the water resources of major river basins, and for the elimination of differences in basic policies between the programs of Federal agencies on such matters as cost sharing and procedures for authorization of projects. The corps also stresses the need for amending basic legislation to more fully reflect the modern concepts of comprehensive and coordinated programs for regulating the major rivers of the Nation for all purposes. Programs of the Corps of Engineers for development of hydroelectric power and reclamation of land by drainage, which are carried out as a part of the flood control program, are discussed.

The report makes a valuable contribution to the program of studies undertaken by the committee and will be of great interest to all members of the committee, to other Senators, and to others interested in river basin development for flood control and other purposes. Accordingly, I am having the report printed as one of our series of committee prints covering all aspects of water resources activities in the United States.

ROB'T S. KERR,
Chairman, Select Committee on
National Water Resources.

COMMUNICATIONS

JULY 30, 1959.

Hon. WILBER M. BRUCKER,
Secretary of the Army, Department of the Army,
Washington, D.C.

MY DEAR MR. SECRETARY: Further reference is made to my letter of June 15, concerning the work of the Select Committee on National Resources. In addition to the report covering the field of water transportation which is now being undertaken by the Corps of Engineers, the committee will also need a study and report on flood control. We believe that the corps, as the Federal agency preeminent in the flood control field, is the appropriate agency to undertake this study. Accordingly, it is requested that a report on the flood control problem of the United States be prepared by the Corps of Engineers.

Principal objective of the report is to inform the committee on flood loss prevention needs and means of meeting them between now and 1980 and looking on to the future. Particular attention should be given to the problem of increasing urban occupancy of flood plains and to preventive as well as protective measures for abatement of flood damages.

The report should contain a brief discussion of the extent and character of past and present flood control programs and needed additional programs. We would like to have included (1) actual and potential average annual flood losses, (2) area of land on flood plains, and (3) costs of works. This should be given by river basin and to the extent practicable should be broken down between urban and rural (including transportation facilities in rural areas). Each category of information should be tabulated by river basin, broken down by types of projects such as levees, other local improvements, single-purpose reservoirs and multiple-purpose reservoirs, as well as by completed projects, projects under construction, authorized projects not yet started, recommended authorized projects, or projects on which favorable reports are anticipated, projects on which unfavorable reports have been made or are anticipated, and finally, losses not susceptible of being covered by projects or not covered by Corps of Engineers studies.

Insofar as practicable, estimates of storage capacity required for flood control and costs thereof in single-purpose and multiple-purpose projects by river basins shall be furnished.

The report should also contain discussion of means of flood loss prevention other than storage, levees, and other physical works, giving potential economic losses and gains from each method, as well as discussion of typical localities and situations for application of these means. This part of the report should cover such means of flood loss prevention as floodproof construction, limited use zoning, use of flood plains for parks, flood forecasting and warning systems, and flood insurance.

We would like this material to be covered in a summary report of about 10,000 words with whatever tables, charts, appendixes, and graphic illustrations as may be considered necessary. It would be most helpful if this information could be furnished the committee by October 15, 1959.

The committee staff will be glad to discuss any problems which may arise in the preparation of the report and to work out the details of the study with representatives of the Corps of Engineers.

Sincerely yours,

ROB'T S. KERR, *Chairman.*

AUGUST 17, 1960.

Hon. ROBERT S. KERR,
Chairman, Select Committee on National Water Resources,
U.S. Senate.

DEAR SENATOR KERR: In response to your original request by letter of July 30, 1959 and to subsequent discussions with the staff of the select committee, I am enclosing a report by the Chief of Engineers on "Floods and Flood Control in the United States."

In accordance with your request the report gives consideration to possibilities of reducing the future flood hazard by measures for flood plain regulation as well as by construction of engineering works. Also, since the present flood control program is multiple-purpose in nature, the report presents the relationship of the present program, and that required for the future, to other water resources problems and needs.

I consider that this is a very complete study of the flood control problem, how it can be met, and of its impact upon the future water needs and development of the United States. I hope that it will be of assistance to the select committee in completion of its important task.

Sincerely yours,

DEWEY SHORT,
Assistant Secretary of the Army (Manpower, Personnel, and Reserve Forces).

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FLOODS AND FLOOD CONTROL IN THE UNITED STATES

A Report Submitted to the Select Committee on National Water Resources, U.S. Senate, by the Secretary of the Army, June 1960

INTRODUCTION

The purpose of this report is to provide the Select Committee on National Water Resources of the U.S. Senate with information on the flood problem in the United States, and on what has been and is being done to solve that problem, and to indicate the course of action that appears necessary to meet the problem in the foreseeable future, or by 1980.

Although flood control in the United States began as a matter of local concern, the Federal interest in the problem has grown until flood control has become one of the major public works activities of the Federal Government. Furthermore, the growth of Federal interest through legislation has developed from a single-purpose effort to reduce flood damage to consideration of flood control as a major element in the multiple-purpose development of our rivers and streams. Consequently, this report attempts to show the relationship of flood control to other aspects of water resources development and its essential role in our efforts toward the more complete regulation of our rivers that will be required to meet the Nation's future needs.

Since there has been a lack of public understanding of the flood problem, and of means of coping with it, this report presents definitions and discussions in "layman's" language which may appear elementary to engineers and economists who have been engaged for years in flood control studies and activities. It is hoped, however, that this approach will help avoid confusion and aid in a clear appraisal of future needs and how these can be met.

SECTION I—THE FLOOD PROBLEM

CAUSES OF THE FLOOD PROBLEM

The flood problem in the United States results from the conditions of hydrology and topography of our river basins which produce the runoff that appears in streams and rivers as floodflow, from the capability of channels and flood plains to pass such flows, and from the extent to which river valleys are used and developed. Floods are natural phenomena and it should be understood that the flood plain of a river is just as much a part of its natural course as the channel within banks which carries normal and low flows.

There is nothing new about great floods; they occurred in this country long before the white man converted forest, prairie, and plain to farms and ranches. As a matter of fact, the flood of 1543 in the lower Mississippi Valley, observed by the remnants of Hernando de Soto's party, the first white men ever to gaze upon that mighty river, was probably larger than any flood experienced since that time. It is certain that over the centuries many great floodflows occurred on numerous other rivers throughout the vast area which was to become the United States. But there was no flood problem until the white man began to settle in the river valleys, and thus gave floods something to damage.

Thus, in a real sense the flood problem is caused by people. If man had left the flood plains to the streams that created them, there would be no flood damage, and no flood problem. But man has had very good reasons for his unrelenting efforts to wrest valley lands from the streams to which, under the laws of nature, they belong. Bottom lands are normally more fertile and easier to till than uplands, and it is less costly for man to build his cities and other works on relatively flat valley bottoms. In addition, when the country was first settled the rivers constituted the main avenues of commerce. There are still advantages to be gained by locating cities on navigable waterways and certain industrial developments are attracted to river valleys by a readily available water supply.

The battle between man and streams for possession of flood plains lands has been long and costly. It has been costly to those who settled on the flood plains and have had to suffer the damages inflicted by floods. It is proving costly to the Nation to make it possible for the owners of flood plain lands to utilize them as intensively as they desire. At this time the development of flood plain lands is taking place so rapidly that, in spite of the effectiveness of Federal flood control works, the flood damage potential in unprotected or in partially protected areas appears to be increasing.

KINDS OF FLOODS

What is a flood?—The picture created in the mind of the average citizen by the word "flood" is one of a river which has overflowed the land lying along the channel in which it normally flows. This is the most common type of flood. But the general public has no difficultly in broadening its concept of a flood to encompass the inundation of lands adjacent to seas or lakes as a result of hurricanes or abnormal tides. A generally acceptable, and easily understood, definition of a "flood" is, therefore: An overflow of lands which, although they are adjacent to water, are not normally covered by it, and hence are used (or usable) in the same way that other lands are used. There are, however, many kinds of floods and a number of ways in which floods may be classified or described. An understanding of the kinds of floods and their characteristics is important to proper consideration of their impact and of methods for controlling them.

Catastrophic and ordinary floods.—Floods of unusual magnitude which cause great damage, and which are often accompanied by considerable loss of life, are often referred to as catastrophes or disasters. Although such floods can occur at any time, and have occurred quite frequently in the same river valley, the length of time between such floods in a given river valley is usually very great. In fact, one reason that great floods are so destructive is that they occur so seldom that people tend to forget them and hence develop and use flood plains as though such floods would never occur. But the main point to be made here is that the general public has a strong tendency to classify floods according to the seriousness of the damage they cause. In this classification floods are roughly divided into "disasters" and "ordinary floods." Over a long period of years, and in many localities, the aggregate damage caused by ordinary floods greatly exceeds that resulting from the great floods called to public attention by spectacular newspaper stories. There are real reasons, however, for the concentration of public attention on the great floods. One of these is the loss of life and suffering which they cause. Another is the shock suffered by the local, regional, or national economy when such floods occur, for their economic impact cannot be absorbed without great hardship. It was this type of flood that led the Congress to shift to the Federal Government the main burden of responsibility for flood control by enactment of the Flood Control Act of 1936.

Downstream and upstream floods.—It is also customary for the public to think of floods in terms of those experienced on main rivers and major tributaries (sometimes referred to as "downstream" floods) and those which occur on creeks and other small headwater streams (often referred to as "upstream" floods). These two types of floods differ radically. Floods on the larger rivers rise and fall slowly and often inundate the flood plains for many days or weeks. Headwater floods usually rise and fall very rapidly and in many instances the flood plain is under water for but a few hours. There is also a vast difference in the causes of these two types of floods. Floods on great rivers like the Mississippi or Ohio are caused by long continued storms, or series of storms, covering vast areas and precipitatating, in the aggregate, great volumes of water at relatively low intensities. These are also caused, or accentuated, at times by melting snow. In contrast, flood stages on small headwater streams are usually caused by very intense rains of the summer thundershower type, covering relatively small areas. Floods on headwater streams are often referred to as "flash floods" because of the speed with which they rise and fall. In steep areas such as the western mountains, the rate of rise for small area floods may be almost instantaneous, with the front of the flood wave coming down the channel as a "wall" of water.

Classification by cause.—Floods are also classified by their cause. Floods result from excessive rainfall, melting snow, action of wind on bodies of water, or from a combination of causes. Floods resulting from melting snow are often called snowmelt floods. Floods aggravated by wind are usually the result of hurricanes, and such events are commonly referred to as "hurricane" floods. When no modifying adjectives are used, it is understood that the flood referred to is caused by rainfall. Another classification of floods depends upon the concentration of the solids carried by the water. In steep, and largely bare, areas in the arid West the solid content may be so high that the flood is referred to as a "debris" flow.

Classification by frequency.—perhaps the most useful classification of floods is in terms of their frequency of occurrence. While it may be sufficient for the general public to think of floods as rare or ordinary, the engineer and economist concerned with planning and evaluating projects for reducing flood damage must have a quantitative measure of frequency. Hence, they attempt to determine as realistically as possible the relationship between flood magnitude and frequency (or probability of occurrence). This is expressed either as (*a*) the average time interval between floods equal to or larger than a given size, or (*b*) the number of floods of that size or larger which may be expected to occur on the average during a given period—usually 100 years—or (*c*) in terms of the chance of occurrence of a given flood in any one year. This permits reference to a flood, for example, as a "hundred-year flood."

Such a designation of a flood indicates its relative importance as a contributor to average annual damage, as well as from the standpoint of relative magnitude. In using frequency terms, however, such as "hundred-year flood" it should be thoroughly understood that just because a flood so designated has just occurred it is not true that it will not occur again for 100 years. In fact, it may occur again next flood season or at any time, although the chance of such occurrence may be remote.

Other definitions.—There are other definitions of floods and of terms such as "maximum probable flood," "standard project flood," and "design flood" which are used by those engaged in planning and design of flood control works. In addition, there are terms used in describing and dealing with the flood problem. These more technical definitions and terms are presented in supplement A to this report.

FLOOD DAMAGE IN THE UNITED STATES

Flood damages that may be anticipated at any point in time are the best measure of the magnitude of the flood problem. Thus, the magnitude of the Nation's flood problem may be measured by the damages its citizens would suffer in the future if nothing further is done to reduce the magnitude and frequency of flooding. Past flood damages measure the magnitude of the flood problem only to the extent that they aid in forecasting future flood damages.

What is flood damage?—Flood damage, or the economic loss caused by floods, may be either direct or indirect (associated). Direct damage occurs in the flood plains of rivers and streams when buildings and other structures, goods, agricultural crops, and livestock are damaged or destroyed by water. In some cases this amounts merely to damage by inundation, while in others the velocity of the water adds to the destruction. Direct damage also includes the erosion or scouring of land and the deposition of infertile sediment in the overflowed area. Direct damages are usually estimated separately for urban and industrial areas, and for utilities such as highways, bridges, electric lines, and railroads. Floods also cause indirect or associated losses from disruption of economic activities. These may occur within the flood plain, in adjacent areas, and in the case of great floods at points far distant from the area of overflow. In addition, floods cause intangible damages, or those which it is not possible to measure in monetary terms. Loss of life is, of course, the most important of these intangible damages. Akin to this is the fear and misery suffered by those whose homes lie in the path of floodwaters.

Future or potential flood damages depend upon (*a*) the frequency and magnitude of the floodflows to be expected, (*b*) the areas subject to inundation by these floods, and (*c*) the probable future uses of those areas. The frequency of floods of any magnitude can be approximated by analyzing past flood records. The areas subject to inundation may be determined by surveys of the areas overflowed by past floods and by hydraulic calculations. The future use of the flood plain will depend upon desirability for urban, industrial, or agricultural development, and upon any limitations which may be placed upon that development by the "regulation" of flood plain use as a means of forestalling future flood damages.

Since the purpose of flood control is the reduction of future flood damage, those who plan for flood control are concerned with the record of past flood damage as an indication of what the future may bring. They must consider not only the relatively rare flood disasters but also the continuing economic impact of all floods which is reflected in the average annual flood damage. The average annual damage is of particular concern because year in and year out the benefit creditable to a flood control project is the difference between the flood damage that would occur without the proposed project and that which would occur with the project in operation. Thus the spectacular damages caused by great floods and the average annual damages which gradually drain the Nation's wealth are both of interest and importance.

Flood damages of the past.[1]—The incomplete record of flood damage which has come down to us from the past is that for great floods which caused serious loss of life and major damages to property. We also have records of major floods which swept down wilderness river valleys long before the white man settled in those valleys, but these passed with no damage or impact except as temporary deterrents to exploration and trade. These earlier records of floods serve not only to emphasize that the flood hazard in the area of the United States has existed since time immemorial, but that the flood problem has arisen and increased only since we began to use the river valleys.

Floods of the past which resulted in great loss of life and those which caused extraordinary property damage are listed in tables 1 and 2, respectively. The earlier recorded floods are those resulting from failure of dams or from hurricane-driven waters. The record indicates, however, that between 1900 and 1940, when the Federal flood control program first began to be effective, floods causing loss of 100 lives or more occurred quite frequently or about every 3 years on the average. On the other hand during almost 2 decades since 1940 the country has experienced only 2 floods which took more than 100 lives. This less frequent loss of life has been due in part to the provision of Federal flood protection works

TABLE 1.—*Flood disasters in the United States causing more than 100 deaths*

Year	Stream or place	Lives lost	Cause [1]
1874	Tributary of Connecticut River.	143	Failure of small dam.
1889	Johnstown, Pa.	2,100	Do.
1893	South Atlantic coast	2,000	Hurricane.
1900	Galveston, Tex.	6,000+	Do.
1903	Kansas, lower Missouri, and upper Mississippi Rivers.	100+	
1903	Heppner, Oreg.	247	Cloudburst on 20 square miles.
1913	Miami, Muskingum, and Ohio Rivers.	467	
1913	West Texas rivers	177	
1921	Upper Arkansas River	120	
1926	Lake Okeechobee, Fla.	350	Hurricane.
1927	Vermont	120	
1927	Lower Mississippi River	313	
1928	San Francisquito Valley, Calif.	350	Failure water supply dam.
1928	Lake Okeechobee, Fla.	2,400	Hurricane.
1935	Republican and Kansas Rivers.	110	
1935	Florida Keys	400	Hurricane.
1936	Northeastern United States.	107	General storm plus snowmelt.
1937	Ohio River	137	
1938	New England	500+	Hurrricane.
1955	Northeastern United States.	187	Do.
1957	Gulf Coast, La. and Tex.	430	Do.

TABLE 2.—*Flood disasters in the United States resulting in damage exceeding $50,000,000*

Year	Stream or place	Damage (millions)		Cause [1]
		Contemporary dollars	1959 dollars	
1889	Johnstown, Pa.	20	80	Failure small dam.
1900	Galveston, Tex.	25	100	Hurricane.
1903	Kansas, lower Missouri, and upper Mississippi Rivers.	40	140	
1913	Miami, Muskingum, and Ohio Rivers.	150	490	
1926	Lake Okeechobee	70	136	Hurricane.
1927	Lower Mississippi River	284	565	
1936	Northeastern United States.	270	635	General storm plus snowmelt.
1937	Ohio River	418	946	
1938	San Gabriel, Santa Ana, and other southern California rivers.	79	182	
1943	Central States	172	298	
1944	do	82	139	
1947	Missouri and middle Mississippi.	235	319	
1947	Central and southern Florida.	60	81	Hurricane.
1948	Columbia River	102	130	
1951	Kansas River	935	1,090	
1952	Red River of North and upper Mississippi.	198	227	
1955	Northeastern United States.	714	794	
1955	California and Oregon	172	192	
1957	Ohio Basin	65	68	
1957	Southwestern United States.	125	130	
1959	Ohio Basin	114	114	

[1] Where cause is not listed the flood was a normal river flood caused by excessive rainfall and runoff.

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[1] "Floods" by W. G. Hoyt and W. B. Langbein (Princeton University Press, 1955) contains a comprehensive history of floods in the United States which was of great value in the preparation of this section.

which have reduced some of the most serious flood hazards, but it has also resulted from greater public recognition and understanding of the flood problem, and from the better means of communication and improved flood warning services which have become available in more recent years.

The records indicate, however, that while there has been a marked reduction in frequency of loss of life from floods, the frequency of major property damage from floods has increased substantially. Floods causing damages of $50 million or more (1959 dollars) were experienced during the period 1900–1940 on an average about once every 6 years. Since 1940, floods causing damage in this order of magnitude have occurred on an average of once in less than 2 years. Since there is no evidence that floods themselves are increasing in magnitude and frequency, this increase in occurrence of major property damage seems indicative of the rapid development and use of flood plains. The net result has been that flood damage continues to occur, and to increase [2] in some instances, in spite of the demonstrated effectiveness of the flood control works provided by the Federal Government.

Average annual damages.—There is, unfortunately, no complete record of flood damages in the United States which includes the effect of both great and ordinary floods. For many years the U.S. Weather Bureau has recorded the best information that has been made available to it by county agents, city officials, and others. Admittedly, this record has covered only part of the flood damage suffered in the Nation. The Corps of Engineers has made numerous determinations of flood damage within reaches of streams which would be affected by contemplated corps projects, or within the scope of authorized surveys. These, of course, were not intended to be complete inventories of nation-wide flood damages. Recently the Soil Conservation Service has made estimates of flood damages in many headwater valleys, usually along streams draining less than 250,000 acres (390 square miles). Here again, however, damage estimates have been made in connection with studies of specific projects and cover in detail only a small percentage of all headwater flood plains.

Thus it is not possible to present any complete inventory of past flood damages in the United States. But it is possible to estimate what the future flood damages would be for assumed sets of conditions. Such estimates may be called potential damages to distinguish them from damages actually suffered in the past. In 1957 the Corps of Engineers estimated flood damage potentials for the following conditions:

(1) Use of flood plains as in 1957 with the completed, or essentially completed, flood control projects considered in operation.

(2) Use of flood plain as it will probably be in 1980 with the same flood control projects in operation as for (1) above.

These damage potentials represent flood damages that will occur in the future if no additional projects are undertaken. It is only by reducing future damages that a project can produce "flood damage reduction benefits."

Flood damage potential.—The estimates of flood damage potential developed by the Corps of Engineers included, as nearly as possible, an appraisal of all potential downstream damages, but only those upstream damages for which some reasonable basis for estimating was available. Table 3 presents the results of these estimates. The total damage potential developed by the corps amounted to $698 million annually for 1957 conditions and about $960 annually for 1980 conditions.

TABLE 3.—*Estimated flood damage potential in flood plain areas covered by damage study of the Corps of Engineers* [1]

[Millions of dollars]

Region [2]	1957 conditions			1980 conditions		
	Downstream	Upstream	Total	Downstream	Upstream	Total
New England	16.6	5.9	22.5	19.0	6.8	25.8
Middle Atlantic	38.3	10.4	48.7	46.6	12.6	59.2
South Atlantic	24.4	7.4	31.8	34.8	10.5	45.3
Lower Mississippi	21.6	4.0	25.6	35.4	6.6	42.0
Gulf Southwest	48.3	17.1	65.4	70.0	24.8	94.8
Arkansas-White-Red	39.7	13.2	52.9	45.6	15.1	60.7
Ohio (minus Tenn.)	78.7	24.0	102.7	138.6	41.9	180.5
Upper Mississippi	77.2	11.8	89.0	94.1	14.3	108.4
Great Lakes tributaries	11.4	5.0	16.4	14.0	6.1	20.1
Red River of North	5.6	1.1	6.7	6.7	1.3	8.0
Missouri	103.7	19.4	123.1	123.3	23.0	146.3
Colorado	7.8	1.9	9.7	11.3	2.7	14.0
Great Basin	2.8	.8	3.6	4.5	1.3	5.8
Central Valley, Calif	18.4	4.5	22.9	36.8	8.8	45.6
California coastal	6.7	27.3	34.0	8.9	36.1	45.0
Columbia	33.6	4.4	38.0	45.3	5.9	51.2
North Pacific coastal	3.2	2.2	5.4	4.2	2.9	7.1
Total	[3] 538.0	160.4	[3] 698.4	[3] 739.1	220.7	[3] 959.8

[1] The corps estimates of damage includes all downstream (below 390 square miles) damage, but only part of the upstream damage.

[2] Each region constitutes a river basin or group of basins. See figure 1 for boundaries of regions.

[3] Does not include flood problem in coastal areas due to tidal- or wind-induced flooding.

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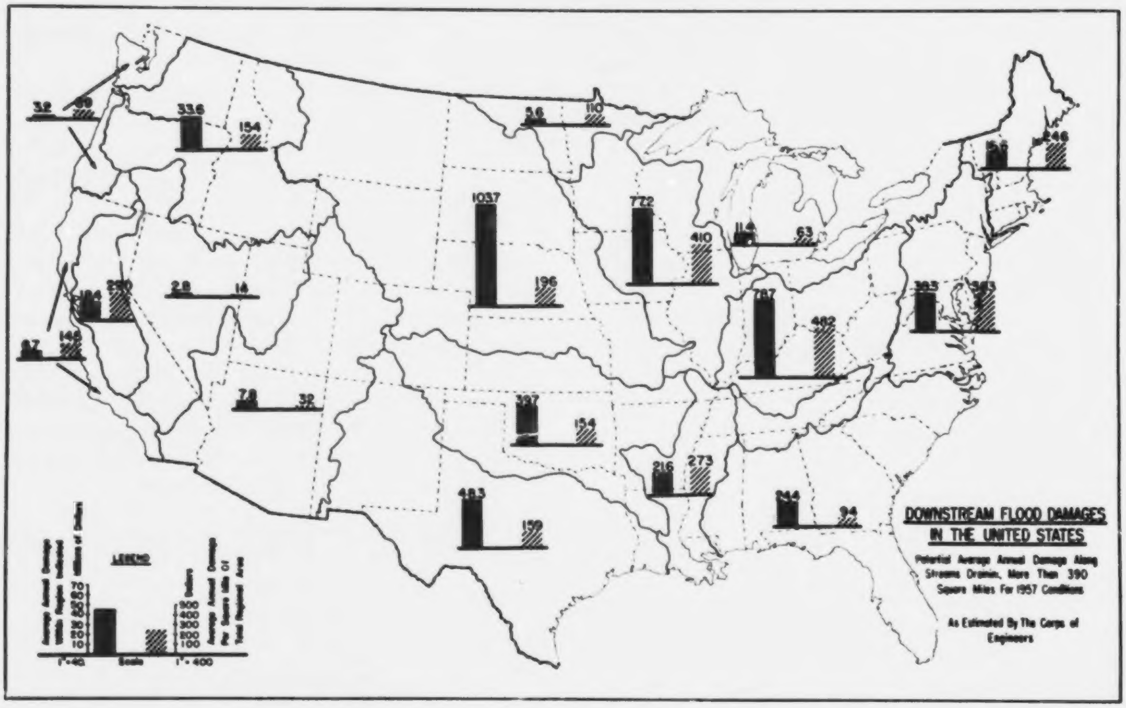
[2] The increase in flood damages was reported upon in a study by White and others: "Changes in Urban Occupancy of Flood Plains in the United States," Research Paper No. 57, Department of Geography, University of Chicago November 1958.

Insofar as downstream benefits only are concerned, this table indicates that if only those projects essentially complete in 1957 were in operation in the future, and the use of the flood plains remained unchanged, the average annual downstream damage over a long period of years would be about $538 million. It also shows that if no further projects are constructed, but if flood plains are permitted to develop in the future as they have in the past, the downstream damage potential by 1980 would be $739 million. In other words, the damage potential will increase by about 37 percent as a result of more intensive utilization of the flood plains. This is equivalent to a growth rate of 1.4 percent per year in flood damages.

The downstream damages shown by table 3 are graphically depicted by figure 1. The variation in damage intensity over the Nation is shown by the bars representing damage per square mile of total area.

FIGURE 1



For the purposes of this report, "upstream flood damage" is defined as that occurring within drainage areas of less than 250,000 acres (390 square miles), because the flood prevention and watershed protection program under Public Law 566 is generally limited to watersheds of less than that area. The totals presented in table 3 present only a part of the average annual damage which may be expected to occur in upstream valleys.

It is not possible to make an estimate comparable in reliability for the total upstream damage potential, as only fragmentary information on upstream damages is available. The Soil Conservation Service has estimated that flood damages in minor valleys might amount to $545 million.[3] However, this estimate included some potential damages along streams draining more than 250,000 acres. Hence it duplicates, in part, the corps estimates of downstream damage set out in table 3. To make it possible to include in this report an estimate of the total damage potential for the United States, a rough estimate of total upstream damages was made by the Corps of Engineers by extending the fragmentary data available at this time. This resulted in an estimate of $417 million for 1957 conditions. This upstream potential should be considered as a rough estimate for interim use until more detailed studies of upstream flood damages become available. At the present time, however, it represents the best estimate of upstream flood damage available to the Corps of Engineers. The total damage potential for the United States would be the sum of this figure and the downstream estimate of table 3 or—

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[3] "Floods and a Program To Alleviate Them" by Ford, Cowan, and Holton. Yearbook of Agriculture, 1955, pp. 171-176.

1957:	Millions
Downstream potential	$538
Upstream potential	417
National potential	955

Assuming that the upstream damage potential will increase at the same rate as the downstream potential, the corresponding figures for the conditions expected in 1980 would be:

1980:	Millions
Downstream potential	$739
Upstream potential	574
National potential	1, 313

The proportion of upstream to downstream flood damage seems large, but it should be understood that a major part of the original downstream flood problem has been reduced or eliminated by flood control works now complete or in operation.

Further analyses of the variation of flood damages over the years, and of the effect of flood control projects on these damages, will be found in section VIII of this report.

The foregoing estimates of total flood damage potential are not precise engineering estimates, but are believed to be sufficiently accurate to indicate the order of magnitude of the flood problem. The Corps of Engineers has estimated that the flood plains of the rivers and streams of the United States total over 100 million acres, or just over 5 percent of the land area of the continental United States. The possibility of such large damage on such a relatively small part of our land area emphasizes the value of the flood plains for development and use and the need for adequate solutions of the flood problem.

SECTION II—SOLUTIONS FOR THE FLOOD PROBLEM

Human occupancy and use of flood plains can be had only by accepting flood damages or by attempting to reduce or prevent them. Thus, finding the best solution for any particular flood problem is basically a matter of considering a number of alternatives. If it is found that any feasible method of reducing flood damage would cost more than the reduction achieved, the alternatives are to allow those who suffer the damages to continue to absorb them, or to spread the losses by such means as disaster relief or by making Federal flood insurance available. If it is decided that measures for reduction of flood damage are essential, a choice may be made between (1) abandonment or evacuation of flood plains, (2) regulation of flood plain use to accommodate it to the flood hazard, and (3) provision of works and measures for flood protection or control. In some cases a combination of these alternatives may offer the best solution.

MEASURES FOR USE WHEN DAMAGES ARE ACCEPTED

Flood relief.—Where flood damages have been relatively minor they are usually permitted to continue. Ordinarily, this is not a conscious decision, but in some instances the choice has been arrived at by an investigation which showed that the cost of abating flood damages would exceed the value of the reduction in damage. Regardless of the way in which this alternative is selected, however, it has become a universal practice in the United States to lessen the impact of flood catastrophes by flood relief. The effect of this is to distribute, by use of public funds and private contributions, a part—although usually but a small part—of the damage to those not directly affected by the flood waters.

Flood insurance.—In recent years considerable support has been generated for "flood insurance" as a means of reducing the economic impact to those who suffer damage from large floods. In 1955, after unusually destructive floods in the northeastern United States, the Congress enacted legislation under which the Federal Treasury would bear a share of the cost of flood insurance. However, funds to put this program into effect have never been appropriated.

In theory insurance enables those subject to flood damage to set aside a part of their income in good years to enable them to bear the cost of damages suffered when the flood comes. Under the program authorized by Congress, a part of the damage would also be shifted to the general public by assumption of part of the cost by the Federal Government. But the important defect of flood insurance is that it does not stop the drain upon the Nation's economy. From the economic standpoint, therefore, flood insurance does not provide an acceptable solution for any flood problem for which damages can be reduced at less cost than the amount of the reduction.

MEASURES FOR REDUCTION OF FLOOD DAMAGES

The terms "flood control" or "flood prevention" are somewhat misleading because it is seldom possible to provide complete control of a flood and it is not possible to prevent them. The term "flood control" is the more accurate of the two and has a long record of common usage. "Reduction of flood damages" is the purpose of flood control. Under the authority of the various flood control acts the Corps of Engineers may consider and recommend all appropriate engineering and other measures for reduction of flood damage.

Flood plain abandonment and evacuation.—Where flood damages become unbearably high, something is ultimately done to lessen them. One way of accomplishing this is simply to abandon use of the flood plain. Such abandonment may be complete or partial as, for example, when cropland is permitted to revert to pasture or woods. Abandonment has, in fact, been the usual solution for the frequently overflowed flood plains which border creeks and small rivers in agricultural areas. In many instances this is a very practical and economical solution. It has often been pointed out that failure to use flood plains of minor streams means that a potential source of production is not being used. But, obviously, no real loss will result from this until that potential production is needed and can be developed at less cost than other means of production available at the time.

Abandonment of larger flood plains to avoid flood loss is not generally feasible. The cost to the Nation of the necessary adjustments would be very high, and the production is usually so great that it could not be absorbed by existing surplus capacity. Nevertheless, sizable agricultural areas on flood plains have been abandoned, and the practicability of this as an answer to some flood problems was recognized by Congress in the Flood Control Act of 1938, which authorized "evacuation" of flood plain lands as an alternative to protecting them.

Even less feasible, from the economic standpoint, than the abandonment of large agricultural flood plains is the abandonment of urban areas. In a few instances this alternative has been used, but economic studies will show that, in general, where large investments have been made in developing a flood plain it will cost less to protect those investments than to abandon them.

A measure for ameliorating flood damage much more commonly resorted to is the temporary abandonment, or evacuation, of flood plain areas. This is the usual procedure in many of the larger river valleys when it is known that a great flood is about to descend. People move to higher ground, taking such of their belongings as they find it possible to move, and do whatever is possible to minimize damage to the properties which cannot be moved. To make this measure more effective, and particularly to insure that it may be used without loss of life, flood warning systems have been devised for the major river valleys.[4] Such systems are essential if reliance is to be placed upon evacuation of flood plain lands as a means of reducing the damage done by great floods. Also essential are carefully prepared evacuation plans which can be placed in operation promptly.

Regulation of flood plain use.—A measure which is receiving progressively greater attention as the Nation's flood plains are more intensively developed, is "regulation of flood plain use." This requires the use of the legislative and police powers of the States, and their subdivisions, to so control the development of flood plains that excessive damage will not be suffered when great floods occur. High hazard areas are frequently set aside, or "zoned," for such uses as stream-front parks. In some instances, buildings are permitted in such zones if they are "flood-proofed" by raising the lowest floor above flood stage or by providing for quick closure of all openings during floods.

As the Nation develops it will find it necessary to use flood plain lands more and more intensively. Flood plain regulation will, therefore, become increasingly important. In fact, it should currently be given a great deal more attention than it has received in the past.

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[4] See "River Forecasting and Hydrometeorological Analysis," a report from the U.S. Weather Bureau to the Select Committee on National Water Resources, U S Senate, printed as Committee Print No 25, of the series "Water Resources Activities in the United States," November 1959.

Confinement of floods.—One of the most used measures for reducing flood damages is the construction of levees, or dikes, to keep the floodwaters from spreading over the entire flood plain. It is by this means that vast areas of the original flood plain of the great Mississippi River have been protected from overflow. Levees are also frequently used for the protection of cities. In some instances floodwalls of reinforced concrete are used instead of levees because of the high value lands in urban areas. Confinement of floods is one of the oldest and most effective means of reducing flood damages.

Reduction of flood stages.—Flood stages may be reduced by (*a*) decreasing flood runoff, (*b*) increasing channel capacity, or (*c*) storing floodflows in reservoirs.

(*a*) Decreasing flood runoff: Early in the present century considerable publicity was given the hypothesis that the removal of forests and cultivation of the land had greatly increased the magnitude and frequency of floods. This led to the conclusion by many that floods could be prevented, or much reduced in magnitude, by reforestation or by the use of "soil conservation" practices. The concept which gave rise to this belief was that such measures—usually referred to collectively as "land treatment" measures—would increase the rate at which precipitation would infiltrate into the soil, and would also increase the capacity of the soil mantle to retain infiltrated water. Research during the past three or more decades has shown that land treatment measures do indeed increase the infiltration capacity, and also, to a limited extent, the storage capacity of the soil mantle. But it has also revealed that these effects are small when compared to the intensities and volumes of storms that produce the larger floods on major rivers. Hence, it is now generally conceded by all who understand the natural processes by which floods are created that land treatment alone is not a feasible measure for reducing large floods.[5] Land treatment measures, however, are of great value in themselves for they conserve the soil and improve its productivity. They also have a considerable effect upon the total amount of water which infiltrates into the soil during the year, as even a small increase in the infiltration occurring during each storm may aggregate several inches of water during the course of a year. Moreover, the effect of such a small increase in infiltration may substantially reduce the peak stages of small floods on minor streams.

(*b*) Increasing channel capacity: A much used means of reducing flood stages, and hence flood overflow, is the enlargement of channels. This is usually accomplished by excavating to increase the depth or width (or both) of the natural channel. Channel capacity may also be increased by reducing the resistance which the channel offers to flow. This is acccomplished by removing "snags" and other obstructions, providing a more uniform cross section, and eliminating unnecessary bends. When large values are at stake, the resistance to flow may be reduced by providing a smooth channel lining. This measure is exemplified by the concrete channels which carry floodflows through Los Angeles and its suburbs. Such channel linings also serve to protect the channel against erosion by the high-velocity flows which a reduction in resistance to flow often induces. Another means of increasing channel capacity is the provision of an alternative channel which comes into play only during great floods. This measure is exemplified by the "floodways" provided at certain points in the Mississippi Valley and in the Sacramento River Valley in California. These floodways do not come into action until a "fuse plug" levee is broken, or gates are opened, as certain flood stages are reached.

(*c*) Storage of floodwaters: The principal means of reducing flood stages is by storing floodwater in reservoirs and releasing it at rates as nearly as possible within the capacity of downstream channels. Such storage may be of a very temporary nature with releases through uncontrolled outlets, or at reservoirs with controlled outlets the stored waters may be held for longer periods of time depending upon the downstream flood situation or in some cases upon need for the water.

Reservoirs as a means of flood control are perhaps of greatest importance from the standpoint of comprehensive river basin development. The same reservoirs which reduce floodflows may often be used to provide water supply, generate power, reduce stream pollution, and provide opportunities for public recreation and for preservation of fish and wildlife. In brief, reservoirs constitute a basic facility for multiple-purpose river development.

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[5] This subject is rather fully treated in "The Flood Control Controversy" by Leopold and Maddock, Roland Press, New York, 1954.

Coastal flood protection.—The provision of measures for reduction of damage from coastal flooding presents a separate and difficult problem. In some cases, as at Narragansett Bay in Rhode Island, the configuration of bays and estuaries permits the construction of barriers to protect against hurricane-driven tides.

On most exposed reaches of shoreline subject to hurricane flooding there may be no practicable way of providing protection. Barriers in such cases may seriously interfere with the natural beauty and recreational value of beach areas. In a limited number of cases, the building up of beaches and sand dunes may afford a reasonable solution. In most cases, however, on exposed reaches of shoreline, the principal reliance for reduction of damage from hurricane floods will probably have to rest with adequate warning service, proper building codes, evacuation plans and routes, and with the zoning of more hazardous areas.

Degree of protection.—Determination of the degree of flood protection to be provided by flood control works is an important and difficult procedure. It is obvious that the degree of protection should vary with the hazard involved. Thus, a levee to protect agricultural land may be quite satisfactory if it is designed to provide the degree of protection which economic analysis shows will result in the greatest excess of benefits over costs, even though the degree of protection may be relatively low—say against a flood of 10-year frequency. On the other hand, an urban area where loss of life may result from failure, or an industrial area where heavy property damage is involved, must be given a very high degree of security not only from the greatest floods of record but from the even greater floods which storm and flood studies indicate may occur.

Different degrees of protection are acceptable for different types of works. For example, if the capacity of a flood channel is exceeded, the water merely spreads out slowly across the flood plain, whereas if a levee or floodwall fails by overtopping, the resulting rush of floodwater into a protected area would cause great destruction and probably loss of life.

Determination of a proper degree of protection is most critical where there is a possibility that, as a result of flood protection, areas which are now agricultural, or lightly developed, will develop intensely for urban and industrial purposes. If the degree of protection originally provided is too low, a false sense of security is induced, unwarranted development is encouraged, and when the great flood comes inevitably the stage will be set for a disaster. Consequently, the Corps of Engineers considers that determination of the proper degree of protection to be provided is the most critical and important decision to be reached in providing for a solution of a flood problem.

SECTION III—HISTORICAL AND LEGISLATIVE BACKGROUND

RESOLUTION OF THE CONSTITUTIONAL ISSUE; 1797-1936

For more than a century after the establishment of the United States its Constitution was interpreted as prohibiting the undertaking of "internal improvements" by the Federal Government; with the single exception that Federal responsibility for the improvement of waterways was considered lawful under the "commerce" clause of the Constitution. But even that authority was not generally acknowledged until 1824, when the famous opinion of Chief Justice John Marshall established that "The power of Congress * * * comprehends navigation within the limits of every State in the Union * * * ."[6] In that same year the Congress appropriated $75,000 to remove certain sandbars and "sawyers, planters, and snags" from the Ohio and Mississippi Rivers as an aid to navigation. This task was assigned the Corps of Engineers. Thereafter for a period of 78 years harbors and and waterways were the only "internal improvements" which the Congress formally acknowledged to be a Federal responsibility. Then in 1902 it authorized the first Federal reclamation projects and, even though at the time it was intended to confine such projects to the public domain, this helped weaken the resistance to internal improvements. But it was not until 1917 that Congress agreed that Federal funds could be used for flood-control projects as such. In that year, as a result of destructive Mississippi floods in 1912, 1913, and 1916, Congress authorized flood-control work on both the Mississippi and Sacramento Rivers. From that time forward the constitutionality of internal improvements for dealing with flood problems was no longer questioned. But this final overthrow of the barrier against Federal internal improvements was not easily achieved.

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[6] *Gibbons* v. *Ogden*, 9 Wheat. 1, 197 (U.S. 1824).

LEGISLATIVE HISTORY

The battle to widen the responsibilities of the Federal Government to encompass internal improvements other than navigation works, revolved almost entirely around the Nation's greatest flood problem: the propensity of the lower Mississippi River to overflow the vast and rich alluvial plain which it had created. It was not until the 1840's that this battle began in earnest. By that time the people of the lower valley, after more than a century of individual, group, and State effort to confine the great river, had come to realize that they must have the help of the whole Nation. By 1845 the demands for aid had grown to such proportions that the political leaders of the valley were able to stage a great convention at Memphis. Another convention to promote Federal assumption of responsibility for the Mississippi was held in Chicago in 1847. More and more Members of Congress became convinced that the Federal Government would have to "do something". Then in 1849 and 1850 great floods came down and it became politically imperative that Congress take action. Thereupon it enacted the "Swamp Land Acts" of 1849 and 1850. These acts granted to certain States swamp and overflowed lands within the public domain on the condition that they be sold and the proceeds utilized for drainage and flood control. This, of course, did not harness the Mississippi, and these acts did not prove to be a satisfactory and workable legislative basis for Federal participation in flood control.

Congress could be persuaded to do no more, however, until after the War Between the States when, in 1874, it appropriated funds for relief work and created a commission to study the problem. The report of this Commission, which became known as the Warren Commission,[7] greatly strengthened the advocates of Federal action, and led directly to the establishment of the Mississippi River Commission in 1879. For its first 11 years this Commission was required by the language of the appropriation acts to confine its attention to navigation. Nevertheless, 1879 marked the turning point in the long battle. From that time forward the Congress gradually became reconciled to the idea that the Federal Government had some degree of responsibility for the development of the Nation through internal improvements. Between 1879 and 1917 Federal funds were made available for some flood-control work by the Mississippi River Commission, but throughout this period the Congress insisted that navigation be the stated purpose of these appropriations. As a result of all these developments the Congress was by 1916 conditioned to accept responsibility for the Mississippi flood problem. The great flood of that year precipitated action, and early in 1917 the first clear-cut flood-control legislation was enacted into law.

While important from the standpoint of national policy, the project authorized in 1917 was not to solve the Mississippi problem. It was not until the act of May 15, 1928, authorized the "Jadwin Plan"[8] that the Congress went far enough to really bring the "Father of Waters" under control. This act dealing with flood control in the alluvial valley of the Mississippi was amended and broadened by legislation in subsequent years which gradually extended the degree of Federal participation.

Although in 1917, and again in 1928, the Congress agreed to assume a high degree of responsibility for the Mississippi and Sacramento, these were considered special problems, and it was not until 1936 that a general flood-control policy was adopted by law. This act will be discussed separately.

Although the issue of Federal authority and responsibility in the flood-control field was fought out, in the main, in the battle for aid to the lower Mississippi Valley, there were other developments which helped pave the way for the 1936 act. As previously mentioned, the Congress authorized "internal improvements" (although on the public domain) by enactment of the Reclamation Act of 1942. In addition it authorized studies, such as that of the Warren Commission, which were later to have a powerful influence on the course of events Other studies were made possible by the 1917 act itself; as, in addition to authorizing the expenditure of Federal funds for works to control the Mississippi and Sacramento Rivers, this legislation gave the Corps of Engineers authority to make studies of other rivers. This authority was broadened in 1927, when the corps was authorized to make comprehensive studies of river basins throughout the Nation. The resulting reports, commonly referred to as "308 reports," were to make possible immediate initiation of an action program under the Flood Control Act of 1936. In addition the Congress authorized in 1930 a project for the control of the hurricane floods in the vicinity of Lake Okeechobee in Florida. While this undertaking was linked with navigation, it was essentially a flood-control project.

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[7] It was headed by General Warren, who was Chief Engineer of the Army of the Potomac at the Battle of Gettysburg and who achieved fame by preventing the Confederate forces from capturing Little Round Top, the "key" to victory.

[8] Named for Maj. Gen. Edgar Jadwin, Chief of Engineers at the time.

Developments outside the Federal sphere were also helping to lay the groundwork for the Flood Control Act of 1936. Communities subject to serious flood damage attempted from time to time to solve their own problems; but, in the main, they did not get much beyond the stage of making investigations and plans, thus strengthening the conviction that eventually the Federal Government would have to take a hand. A notable exception was the work of the Miami Conservancy District which was established under the laws of Ohio in 1913. This entity planned and constructed a series of reservoirs for the protection of Dayton, Ohio, and other communities in the valley of the Miami River.

Also of great importance in establishing the mood which led to acceptance of the Flood Control Act of 1936 was the great depression of the early thirties. The effect of this economic catastrophe was to create an urgent need for work relief projects, as well as to place the cities and States in such bad financial condition that they considered it impossible for them to undertake such projects. Consequently, many flood-control projects were undertaken by the Federal Government under the work-relief programs.

THE FLOOD CONTROL ACT OF 1936

In 1935 legislation was proposed which would have authorized the construction of a large number of flood-control projects, most of which had been developed through the "308" surveys. This legislation failed of enactment. But in 1936 the Senate Committee on Commerce gave intensive and long continued consideration to the formulation of a national policy on flood control. Its work was reflected in section 1 of the act of June 22, 1936, which set the policy for the first general flood-control legislation in the Nation's history. This act did not, however, come into being without travail. There was a great legislative battle over the share of the cost to be assumed by beneficiaries. Also efforts were made, without success, to broaden the bill to establish a reviewing and coordinating agency at the Presidential level. One effort to broaden the legislation did succeed. The Secretary of Agriculture was authorized to prepare plans for the reduction of floods by means of forest improvement, soil conservation, and other land-treatment measures.

The 1936 act in its final form—

(*a*) Established a national policy on flood control;

(*b*) Authorized the construction of some 250 projects, and the appropriation of $310 million to initiate construction, as well as the use of work relief funds, and

(*c*) Authorized numerous examinations and surveys, and the appropriation of $10 million to initiate these investigations.

Of greatest importance for the purposes of this report is the national policy established by the act of 1936. The principle elements of this policy were—

(*a*) The Federal Government would cooperate with "States, their political subdivisions and localities thereof" in flood-control projects (this policy marked the final destruction, after almost 150 years of controversy, of the argument that the Federal Government had no authority to undertake "internal improvements").

(*b*) A two-pronged attack would be made on the flood problem; the Corps of Engineers would develop engineering plans, and the Department of Agriculture land treatment plans, for the reduction of flood damages.

(*c*) To qualify as a Federal project under the act the benefits attributable to a project would have to exceed the costs.

(*d*) Projects would be recommended in survey reports but could not be constructed until specifically authorized by law.

(*e*) Non-Federal interests would provide lands easements, and rights-of-way; would protect the Federal Government from damage claims, and would operate and maintain the flood control works provided by the Federal Government.

SUBSEQUENT FLOOD CONTROL ACTS

The 1936 act was amended and supplemented by the Flood Control Acts of 1937, 1938, 1939, 1940, 1941, 1944, 1946, 1948, 1950, 1954, 1958, and 1960. As the acts of 1938, 1941, 1944, 1950, 1958, and 1960 were important from the standpoint of basic policy, each of them requires some discussion. All of the Federal Control Acts also authorized appropriations for the construction of projects, and for surveys and other studies.

The act of 1938

The act of June 28, 1938, made a major change in the cost-sharing policy of the 1936 act. It provided for Federal assumption of the entire cost of both reservoir and channel improvement projects. This relieved the local interests of the cost of lands, easements, and rights-of-way, except for levee projects.

The 1938 act also authorized the Chief of Engineers to evacuate areas subject to flood in lieu of protecting them by levees or floodwalls, provided for the installation of penstocks in dams, and authorized the use of flood-control funds to collect rainfall data.

The act of 1941

This act (August 18, 1941) again made "channel improvements" subject to the cost-sharing policy of the 1936 act, but retained the 1938 provision, requiring the Federal Government to bear the cost of lands, easements and rights-of-way, for reservoir projects.

The act of 1944

The act of December 22, 1944, greatly extended the national policy laid down by the 1936 act. Of particular importance was the expression of congressional intent that projects were to be considered "on a basis of comprehensive and coordinated development"; a great stride away from the single-purpose concept and toward the concept of comprehensive programs for the development, use and conservation of the resources of major river basins. Other important policies expressed in this act may be summarized as follows:

(*a*) Waters arising in States lying wholly or partly west of the 98th meridian may not be used for navigation if such use would conflict with beneficial consumptive use (this provision has been repeated in subsequent acts);

(*b*) Major drainage improvements may be treated as flood-control projects;

(*c*) The Secretary of the Army shall prescribe regulations governing the operation of flood-control storage constructed wholly, or in part, with Federal funds, regardless of the agency responsible for construction;

(*d*) Power generated at Corps of Engineers projects shall be marketed by the Secretary of Interior;

(*e*) The rights and interests of States in water shall be recognized by the Federal agencies;

(*f*) The sale of surplus water is authorized;

(*g*) The States and the Secretary of the Interior shall be given an opportunity to review Corps reports and to cooperate;

(*h*) The public shall have free access to reservoirs under the control of the Department of the Army, and the Chief of Engineers is authorized to construct and operate public park and recreational facilities, and to permit others to do so.

The act of 1950

This act, approved May 17, 1950, authorized the development of a comprehensive, integrated plan for the region drained by the Arkansas, White, and Red Rivers, as well as an inventory of the resources of the New England-New York region. This was important because it indicated that Congress seriously intended to implement the policy objective of the 1944 act; the achievement of "comprehensive and coordinated development."

The act of 1958

Title III of this act (July 3, 1958) authorized the inclusion, in Corps of Engineers and Bureau of Reclamation reservoirs, of reservoir capacity to impound water for municipal and industrial use, provided an appropriate non-Federal entity should be willing to bear the cost allocable to this capacity.

The act of 1960

Section 206 of this act gives recognition to the increasing use and development taking place in the flood plains of the United Stated and to the need for regulation of such use by States and municipalities as a basis for avoiding future flood hazards. It authorizes the Secretary of the Army, through the Chief of Engineers, when requested by a State or a responsible local governmental agency, to compile and disseminate information on floods and flood damages, including identification of areas subject to inundation, and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard.

Another feature of this act is that it establishes a minimum requirement for local cost sharing for a number of local flood protection projects. It provided for specific projects that local interests assume at least 20 percent of the cost allocable to flood control. It did not, however, make this a general provision of law.

THE WATERSHED PROTECTION AND FLOOD PREVENTION ACTS

Closely related to the foregoing legislation is the Watershed Protection and Flood Prevention Act of 1954, commonly referred to as Public Law 566, and subsequent acts amending and supplementing the 1954 act. The basic purpose of Public Law 566 was to enable the Department of Agriculture to utilize engineering works for the control of headwater floods.

As indicated previously, the Flood Control Act of 1936 authorized the Secretary of Agriculture to propose land treatment projects for the reduction of floods on the same river basins for which engineering plans were prepared by the Corps of Engineers. However, the studies made under this authority soon indicated that the effect of land treatment measures on floods large enough to cause substantial flood damage would be relatively small. These studies also showed that, in the aggregate, considerable flood damage is suffered on the narrow flood plains adjoining the many miles of headwater valley. The Department of Agriculture considered that any substantial reduction in these damages would require the construction of reservoirs or other engineering works, or both. Moreover, it appeared that since the Corps of Engineers was under constant pressure from the Congress, and the interests involved, to give priority to the more serious flood problems of the major rivers and their principal tributaries, the need for engineering measures in headwater valleys would not be met for many years under existing laws, policies, and appropriation limitations. This led to the introduction of the bill which subsequently became Public Law 566. This act authorized the Secretary of Agriculture to assist local organizations to prepare and carry out plans for the reduction of flood damages along streams draining less than 250,000 acres. These plans may encompass both engineering works and land treatment measures. But since adequate legislative authority, established programs, and large appropriations are available for any land treatment work needed within the watersheds for which Public Law 566 projects are planned, the authorities of that act are used almost entirely for the planning and construction of small headwater reservoirs and other engineering works. Not more than 5,000 acre-feet of flood control capacity may be provided for flood control purposes in a single Public Law 566 reservoir.

Public Law 566 also repealed the authorities provided the Secretary of Agriculture by the flood control acts, except the authority to complete the installation of works on 11 river basins.

As originally enacted, Public Law 566 required local interests to provide lands, easements, and rights-of-way and to assume such share of the cost of flood control works as the Secretary of Agriculture should find appropriate. In 1956 the act was amended for the stated purpose of bringing the cost-sharing provisions into consonance with those of the flood control acts under which the entire cost of construction of Federal local flood control works are borne by the Federal Government, but under which non-Federal interests provide lands, easements, and rights-of-way. The same amendatory act considerably broadened the scope of Public Law 566, permitting the Department of Agriculture to construct, at the request of local organizations, engineering works for drainage, irrigation, recreation, fish and wildlife enhancement, municipal and industrial water supply, and other purposes. However, it is only for the "flood prevention" component of Public Law 566 projects that the Federal Government bears the full cost of construction.

The effect of the enactment of the watershed protection and flood prevention acts was to provide the Department of Agriculture with authorities duplicating those earlier given the Department of the Army in the flood control field; that is, it authorized both Departments to provide engineering works for the reduction of flood damages and related purposes. Enactment of Public

Law 566 marked the final abandonment of the idea that floods of substantial size could be significantly reduced by forest improvement, soil conservation, and other land treatment measures. It meant that the Department of Agriculture had found engineering works to be necessary to the control of floods, even on small streams.

THE RECLAMATION ACTS

The Reclamation Project Act of 1939 authorizes the inclusion of additional capacity in Bureau of Reclamation reservoirs for the storage of floodwaters. It also authorizes the assumption by the Federal Government of all costs allocable to flood control. The Flood Control Act of 1944, however, required the Secretary of the Army to prescribe regulations for the operation of such storage capacity.

CHANGING CONCEPTS: 1936–60

When the first general flood control legislation was enacted in 1936, the Congress made it very clear, in hearings, committee reports, and debate, that the Federal Government would participate in only those projects for protecting cities and other urban areas against great, or catastrophic, floods. When specific projects were being selected for authorization by the act, the Senate Committee on Commerce repeatedly rejected projects for the protection of agricultural areas on the ground that these were equivalent to "reclamation projects." Many projects of this kind, however, were subsequently included in the bill finally enacted. As the years went by the Congress began to take a broader view of flood control, and successive flood control acts reflected this by authorizing protection of urban areas not subject to catastrophic damage, then protection of the larger agricultural valleys, and finally of even small agricultural areas.

In 1936, also, the Congress tended to think in terms of single-purpose flood control projects. But it was not long before it became clear that reservoirs for the storage of floodwaters could be used for other purposes, and particularly the generation of electric power. By the time the 1944 act was under consideration, the important concept of comprehensive and coordinated development of the resources of the Nation's major river basins was already understood and accepted by many Members of Congress. By 1950, as previously mentioned, Congress was directing the preparation of a comprehensive and unified plan for the full development of the Arkansas, White, and Red River Basins. Thus, as the years went by, the Federal program being carried out pursuant to the flood control acts became progressively broader in scope. At the present time these acts, although they are still referred to as "flood control acts," constitute the main body of Federal law dealing with the development, utilization, and conservation of the Nation's water resources. Under these acts power is generated and marketed, major outlets are provided to facilitate drainage of land, storage for irrigation water is made available, water is provided for municipal and industrial use as well as for the abatement of pollution and for navigation improvements, recreational facilities are provided, measures for the enhancement of fish and wildlife are carried out, and plans for the comprehensive development, use, and conservation of the water and land resources of major regions are made and put into effect. In short, flood control law has become the legislative basis for the broadest and greatest programs of public works and resource development ever undertaken by the United States.

The development of this body of water resources law has been the result of a step-by-step process, often taken to meet emerging needs of the country. They still contain some features of the single-purpose concept of the act of 1936, however, and do not yet provide all bases of general legislation necessary to implement the concept of optimum multiple-purpose river basin development.

SECTION IV—PROCEDURE UNDER THE FLOOD CONTROL ACTS

The procedure under the flood control acts by which projects are planned, authorized and constructed has been termed a rather long and cumbersome one. It is, however, a very democratic process under which full consideration is given to the needs of local people, the views of affected States, and the requirements of other agencies of the Federal Government. It is also a procedure which provides for a very thorough consideration of the merits of a project, by provisions for review at successive stages of its development.

Since this procedure may not be fully understood by all interested in flood control it is described in some detail in supplement B with this report.

In brief, consideration of a flood problem begins with the request of local people concerned for a survey. When such a survey is authorized by Congress it is accomplished by the Corps of Engineers as soon as funds are appropriated to be used for that purpose. During the course of the survey the views of local interests are sought by means of public hearings, and coordination with States and other Federal agencies is effected at field level by the district engineer charged with conduct of the study.

When completed the report passes through successive stages of review by the division engineer, Board of Engineers for Rivers and Harbors, and Office, Chief of Engineers. Comments of the Governors of States and heads of the various Federal agencies are secured. These along with the recommendation of the Chief of Engineers are furnished by the Secretary of the Army to the Bureau of the Budget for review. The report then goes to Congress with the statement from the Bureau of the Budget as to conformity with the program of the President.

Reports on flood control projects received by the Congress are usually considered by the Public Works Committees at intervals of from 2 to 4 years for inclusion in flood control legislation. Public hearings are held by these committees at which testimony by local interests and by the Corps of Engineers and other Federal agencies is heard. When legislation including a specific project is enacted into law that project becomes a part of the authorized program and eligible for appropriations for design and construction.

Since a single "omnibus" flood control act may authorize a large number of projects some years may elapse before it is possible for the Congress to appropriate funds to place the work underway. When funds become available the project is designed and built by the Corps of Engineers usually by contract with private construction firms. When local flood protection projects are completed they are turned over to local interests for maintenance and operation in accordance with instructions provided by the Department of the Army. Reservoirs for flood control or for multiple-purposes are maintained and operated by the Corps of Engineers.

SECTION V—THE AUTHORIZED FLOOD CONTROL PROGRAM

The present authorized flood control program of the Corps of Engineers consists of over 900 projects having a total estimated Federal cost of $8.8 billion. Of this amount about $1 billion is for authorized projects which are presently classed as deferred for restudy, thus leaving an active authorized program of $7.8 billion. Most of these projects embrace plans for the comprehensive development of river basins not only for flood control but also for the associated conservation, control, and other beneficial uses of the water resources of the basin. This program was developed through the survey report procedure which formed the basis for legislative acts reviewed in section III of this report.

Federal investment.—The first funds approriated to the Corps of Engineers specifically for flood control were for the purpose of initiating the Mississippi and Sacramento River projects in 1918. Since that time, and through June 30, 1960, Federal funds appropriated for flood control have totaled $4.59 billion, as indicated below:

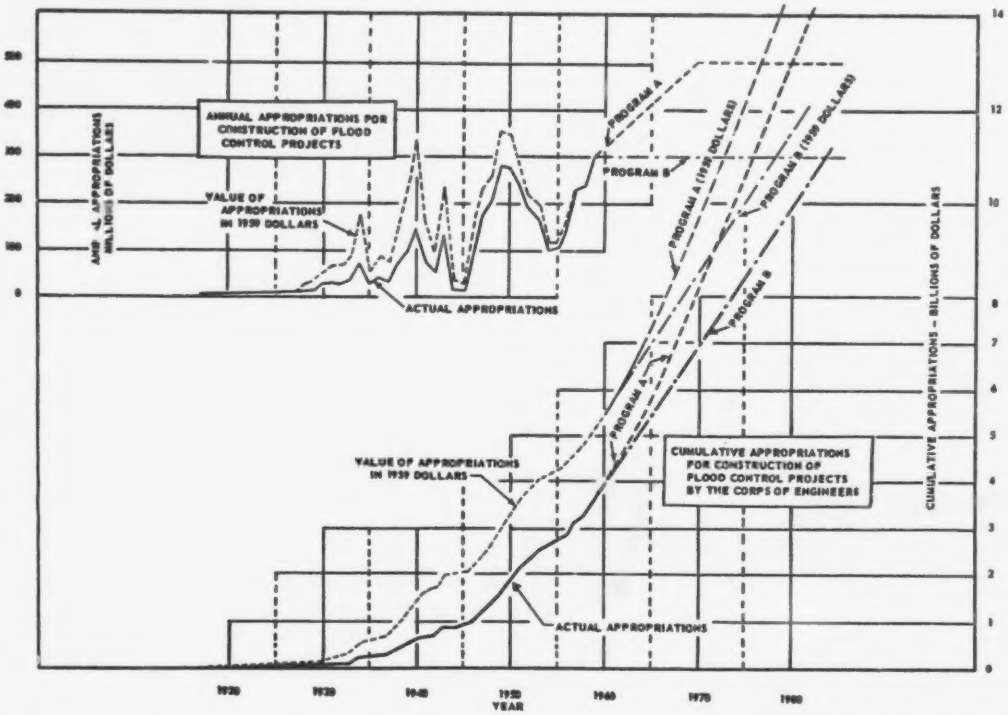
	Billion
(1) Local flood protection projects and reservoirs primarily for flood control, and without power authorized under the general flood control program	$2. 85
(2) The project for the alluvial valley of the the Mississippi, exclusive of the part allocable to navigation	1. 04
(3) The part of "multiple-purpose projects including power" allocable to flood control	. 57
(4) Surveys, administration and miscellaneous	. 13
Total	$4. 59

These appropriations have been utilized as follows:

	Billion
Construction of works	$3. 96
Maintenance and operation	. 50
Surveys, administration, and miscellaneous	. 13
Total	4. 59

Figure 2 depicts the rate of annual appropriations, and cumulative appropriations to date. It also shows possible projections discussed subsequently in section VIII.

FIGURE 2.—RATE OF ANNUAL APPROPRIATION



STATUS OF THE ACTIVE PROGRAM

The general status of new construction of the active authorized flood control program of the Corps of Engineers is given below in table 4. This includes that portion of "multiple-purpose projects including power" and of the project for the alluvial valley of the Mississippi River allocable to flood control; but excludes superseded and abandoned work and work accomplished under continuing general authorities. Overall, the authorized flood control program is 43 percent complete, based on the status of appropriations through fiscal year 1960. The status according to major river basins or regions is given in table 5. The figures presented herein do not reflect the work authorized by Public Law 86-645, approved July 14, 1960, which would add about $0.3 billion to the authorized flood control program.

Table 4.—*General status of new construction*

[In billions of dollars]

Status [1]	Estimated Federal cost	Funds appropriated through fiscal year 1960	Funds to complete
Complete	1.35	1.35	
Under construction	4.35	2.44	1.91
Not started [2]	3.07	.02	3.05
Total	8.77	3.81	4.96

[1] Certain major projects are carried in their entirety in an under-construction status even though some separable units of such projects are physically complete. However, such units are shown as complete in supplement C which lists individual projects and units thereof according to physical status.

[2] Includes $994 million for projects in a deferred for restudy category. Certain authorized projects now classed as inactive with an estimated cost of $800 million have been excluded.

Table 5.—*Status of flood control program by major basins or regions*

[In billions of dollars]

Region	Estimated Federal cost	Appropriations through fiscal year 1960	To complete	Percent appropriated
New England	0.26	0.14	0.12	5[illegible]
Middle Atlantic	.44	.18	.26	[illegible]
South Atlantic	.30	.08	.22	27
Lower Mississippi	1.18	.87	.31	74
Gulf Southwest	.51	.18	.33	35
Arkansas-White-Red	.99	.45	.54	45
Ohio (minus Tennessee)	1.65	.52	1.13	32
Tennessee Basin [1]	(+)	(+)	(+)	47
Upper Mississippi	.69	.15	.54	22
Great Lakes	.08	.04	.04	50
Red River of North	.02	.01	.01	50
Missouri	1.16	.42	.74	36
Colorado	.04	.03	.01	75
Great Basin	(+)	(+)	(+)	67
Central Valley	.44	.21	.23	47
California coastal	.46	.31	.15	67
Columbia Basin	.49	.17	.32	36
North Pacific	.05	.05	(+)	85
Alaska	.01	(+)	(+)	10
Hawaii	(+)	(+)	(+)	3
Total	[2] 8.77	3.81	4.95	43

[1] Does not include projects of the Tennessee Valley Authority.

[2] Includes about $994 million for authorized projects which have been classified as "deferred for restudy."

Note.—Plus sign (+) indicates less than 0.005 million.

PROJECTS COMPLETED AND UNDER CONSTRUCTION

All projects completed or under construction by the Corps of Engineers, which have been undertaken in whole or in part for the purpose of reducing flood damages, are listed in supplement C to this report. The locations of the individual projects are indicated on figures 3A and 3B.

The total estimated Federal cost of flood control works of the Corps of Engineers which have been completed or are presently under construction is $5.7 billion. The nature and magnitude of the entire program is indicated by table 6. To the extent data are available, local costs under this program are indicated to be over $0.5 billion, giving a total estimated first cost of this program, both Federal and non-Federal, of about $6.2 billion. This program entails about 87 million acre-feet of flood control storage in 219 reservoirs, over 9,000 miles of levees and floodwalls, and about 7,400 miles of channel improvement. The geographic distribution of this program by major river basins or regions is shown in table 7. A graphic presentation of the flood control program is shown on figure 4.

The incomplete estimate of local, or non-Federal, costs amounting to over $0.5 billion represents the cost of lands and relocations, and cash contributions in some cases, for local flood protection projects. This is about 25% of the total cost of local flood protection projects authorized under the general flood control acts. The single large project for the alluvial valley of the Mississippi River, which includes both navigation and flood control, was authorized by separate legislation essentially at Federal cost, because of its unique nature and the large costs previously incurred by States and local interests in providing for flood protection.

Table 6.—*Total 1st cost of flood control projects of the Corps of Engineers which are completed or under construction*

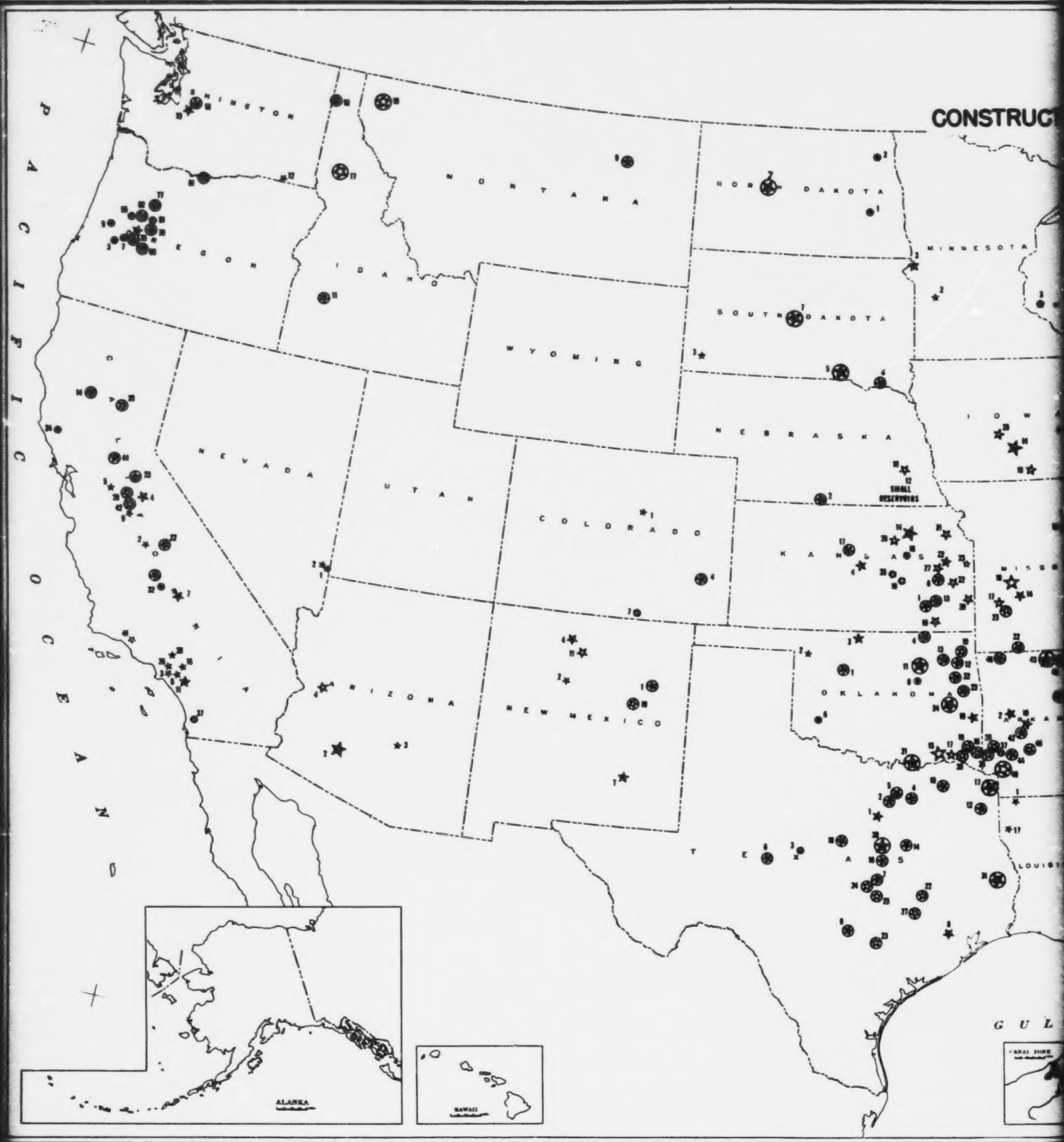
[Dollars in millions]

Type of project	Number of projects	Total 1st cost [2]
PROJECTS INDIVIDUALLY AUTHORIZED BY ACT OF CONGRESS [1]		
Reservoirs without power	177	$2,081.6
Reservoirs with power	37	752.4
Local protection by levees and channel improvements	399	1,736.5
Mississippi River and tributaries project	1	
Reservoirs (5)		82.7
Levees, etc.		1,036.3
Subtotal	614	5,689.5
PROJECTS NOT INDIVIDUALLY AUTHORIZED [3]		
Reservoirs without power	4	$0.8
Local protection projects	79	13.2
Subtotal	83	14.0
ALL FLOOD CONTROL PROJECTS		
Reservoirs without power	181	$2,082.4
Reservoirs with power	37	752.4
Local protection projects	478	1,749.7
Mississippi River and tributaries project	1	
Reservoirs (5)		82.7
Levees, etc.		1,036.3
Total	697	5,703.5

[1] Projects which have been specifically authorized by an act of Congress. The conditions of authorization are stated in such acts.

[2] Costs given are those allocable to flood control. They include the actual 1st cost of completed projects and the estimated final cost of projects under construction.

[3] Small projects authorized by the Secretary of the Army under the authorities of Public Law 685, 84th Cong., or earlier legislation amended and supplemented by that act.


CONSTRUC
PACIFIC OCEAN
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISS
ARKAN
LOUISI
SMALL RESERVOIRS
GUL
ALASKA
HAWAII
CANAL ZONE

UNITED STATES
BASE MAP

FIGURE 3A

RESERVOIR PROJECTS

CONSTRUCTED, UNDER CONSTRUCTION, OR AUTHORIZED FOR CONSTRUCTION BY THE CORPS OF ENGINEERS FOR FLOOD CONTROL AND OTHER PURPOSES

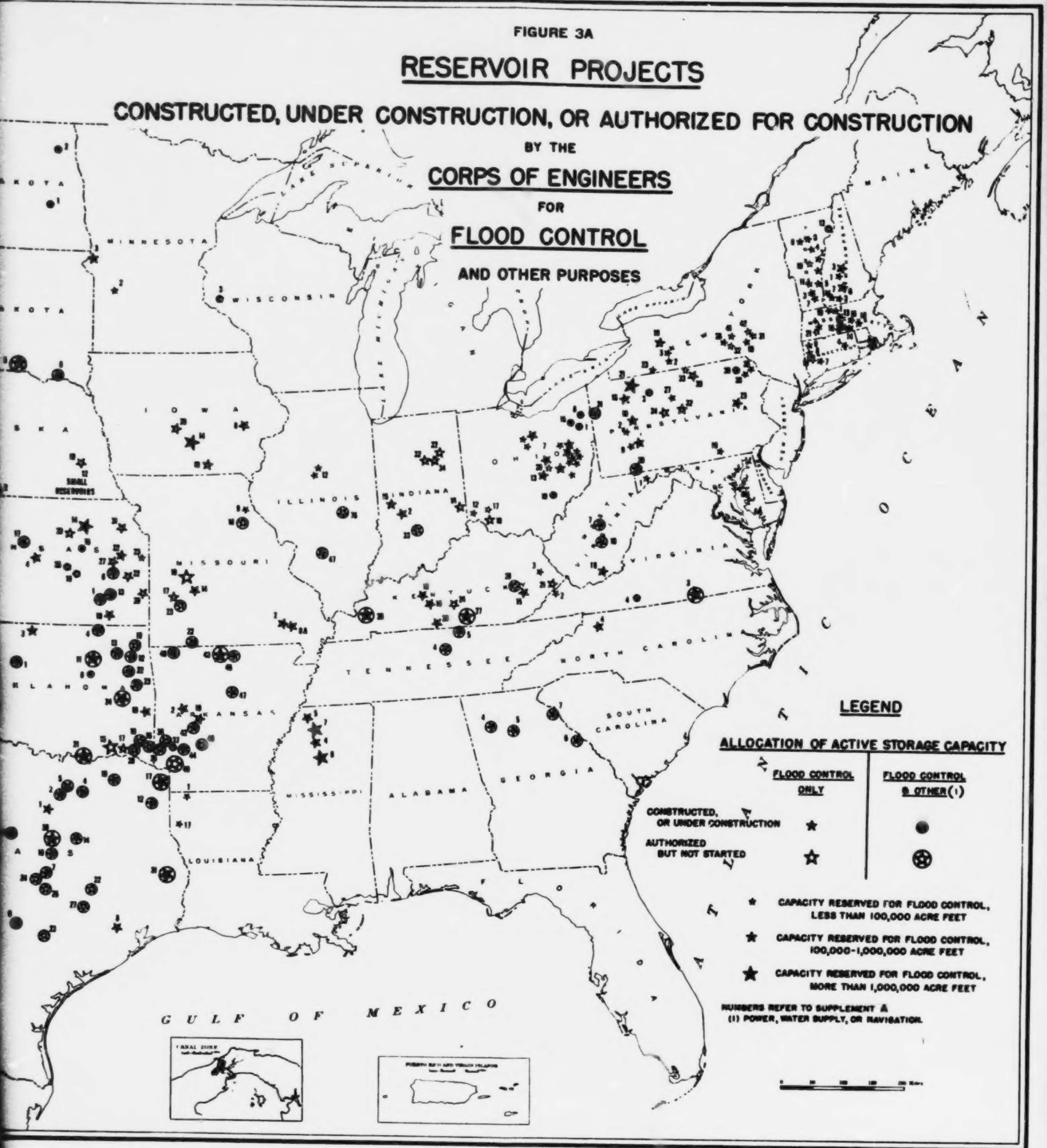
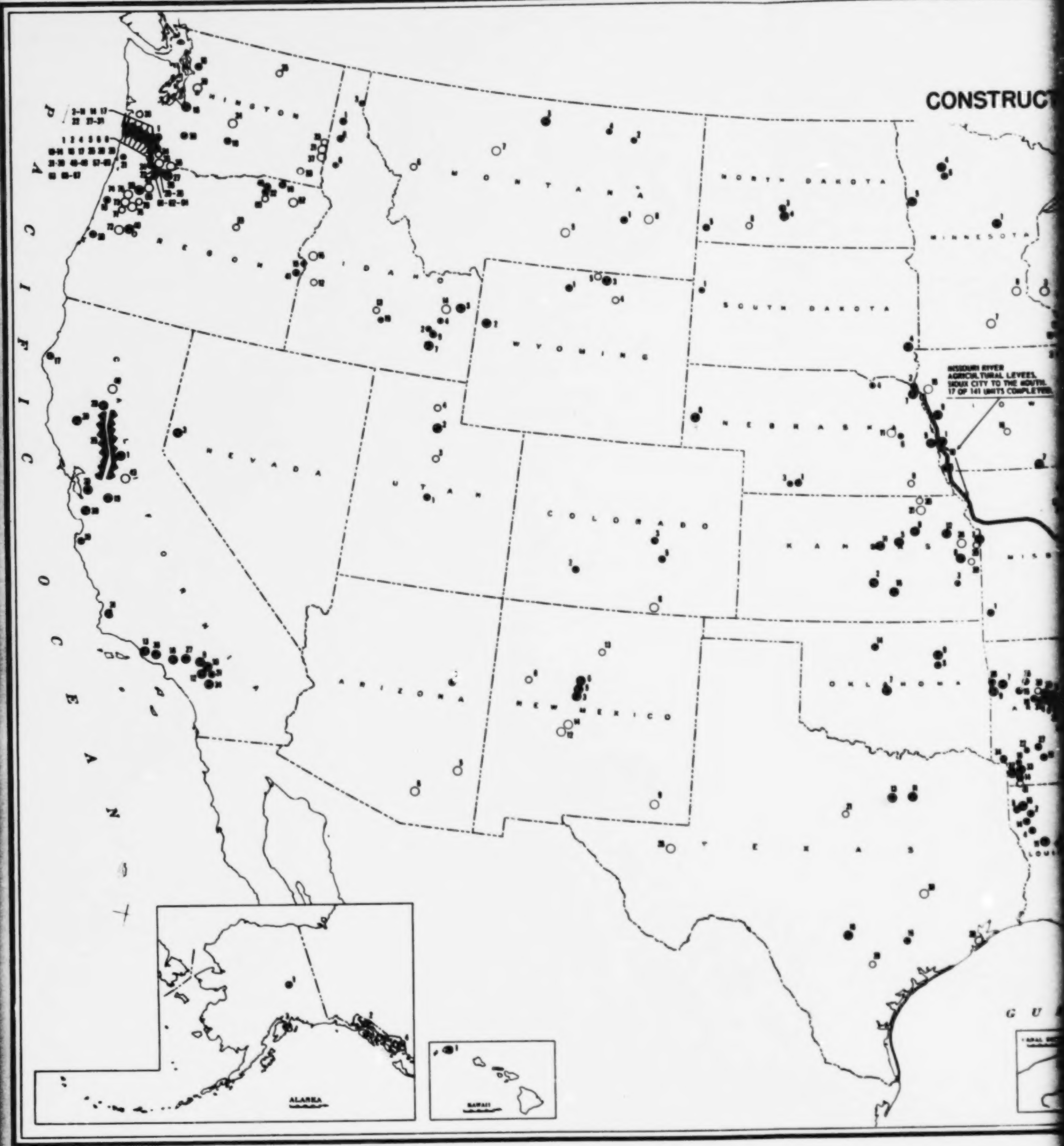

MINNESOTA
WISCONSIN
IOWA
ILLINOIS
INDIANA
OHIO
MISSOURI
KENTUCKY
TENNESSEE
NORTH CAROLINA
VIRGINIA
SOUTH CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
LOUISIANA
ARKANSAS
OKLAHOMA
FLORIDA
NEW YORK
PENNSYLVANIA
MAINE
LAKE SUPERIOR
LAKE MICHIGAN
SMALL RESERVOIRS
ATLANTIC OCEAN
GULF OF MEXICO
CANAL ZONE
PUERTO RICO AND VIRGIN ISLANDS
LEGEND
ALLOCATION OF ACTIVE STORAGE CAPACITY
FLOOD CONTROL ONLY
FLOOD CONTROL & OTHER(1)
CONSTRUCTED, OR UNDER CONSTRUCTION
AUTHORIZED BUT NOT STARTED
CAPACITY RESERVED FOR FLOOD CONTROL, LESS THAN 100,000 ACRE FEET
CAPACITY RESERVED FOR FLOOD CONTROL, 100,000-1,000,000 ACRE FEET
CAPACITY RESERVED FOR FLOOD CONTROL, MORE THAN 1,000,000 ACRE FEET
NUMBERS REFER TO SUPPLEMENT A
(1) POWER, WATER SUPPLY, OR NAVIGATION

FIGURE 3A


CONSTRUCT
PACIFIC OCEAN
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
MISSOURI RIVER AGRICULTURAL LEVEES, SIOUX CITY TO THE MOUTH. 17 OF 141 UNITS COMPLETED.
GU
ALASKA
HAWAII

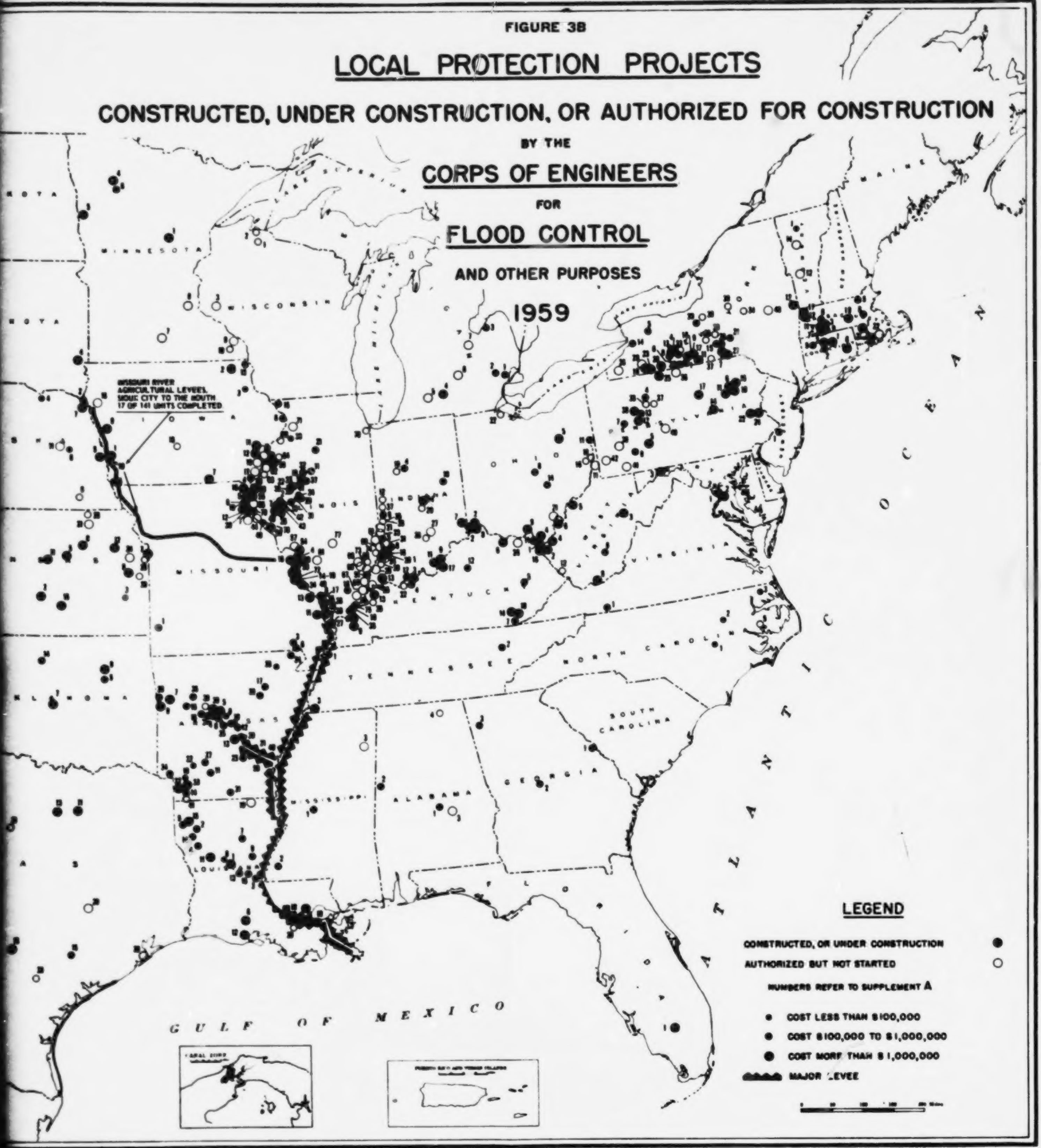


FIGURE 3B

LOCAL PROTECTION PROJECTS

CONSTRUCTED, UNDER CONSTRUCTION, OR AUTHORIZED FOR CONSTRUCTION

BY THE

CORPS OF ENGINEERS

FOR

FLOOD CONTROL

AND OTHER PURPOSES

1959

FIGURE 3B

FIGURE 4

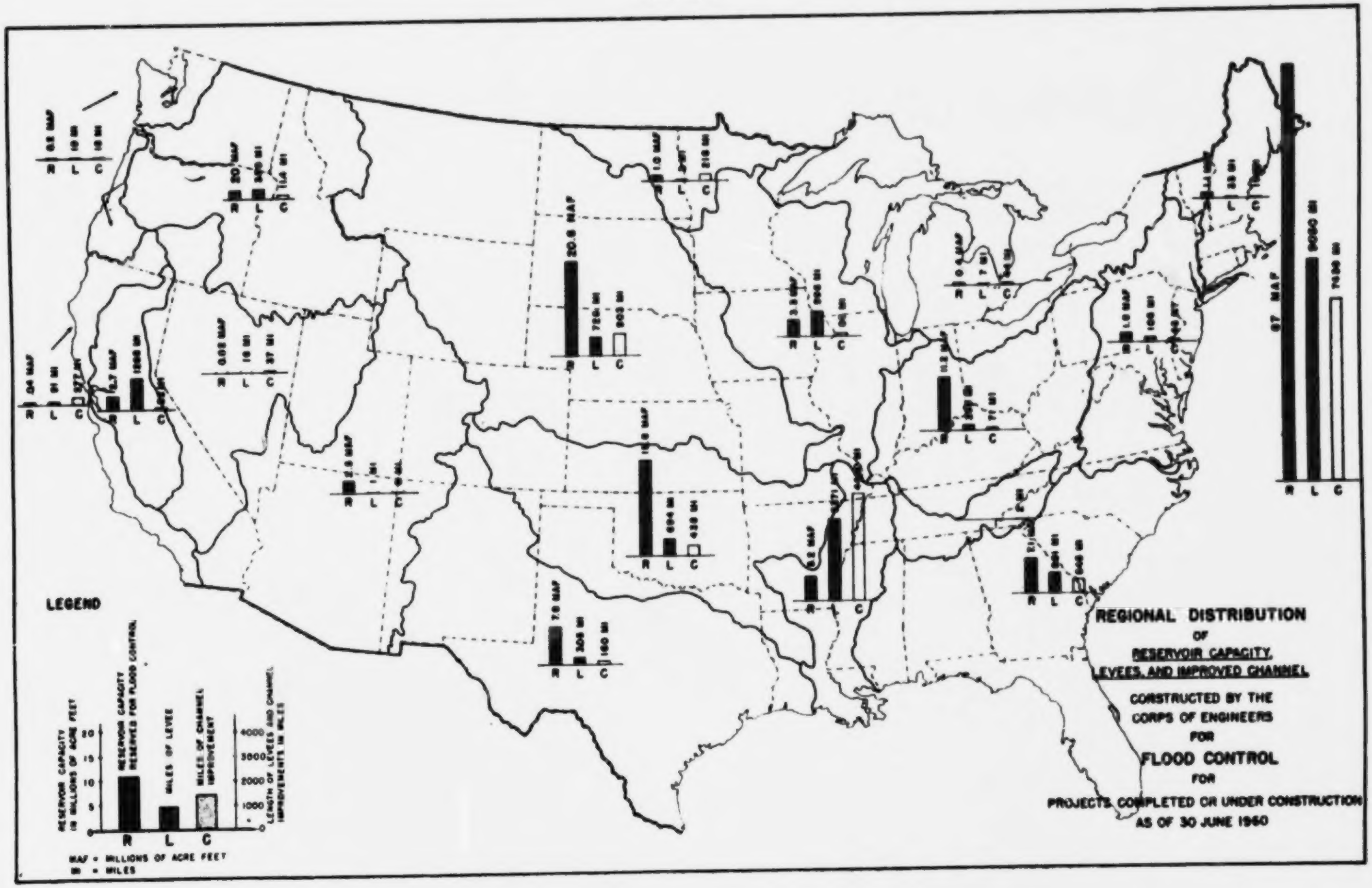

REGIONAL DISTRIBUTION
OF
RESERVOIR CAPACITY,
LEVEES, AND IMPROVED CHANNEL
CONSTRUCTED BY THE
CORPS OF ENGINEERS
FOR
FLOOD CONTROL
FOR
PROJECTS COMPLETED OR UNDER CONSTRUCTION
AS OF 30 JUNE 1960
97 MAF
9080 mi
7430 mi
LEGEND
RESERVOIR CAPACITY IN MILLIONS OF ACRE FEET
0
5
10
15
20
RESERVOIR CAPACITY RESERVED FOR FLOOD CONTROL
MILES OF LEVEE
MILES OF CHANNEL IMPROVEMENT
LENGTH OF LEVEES AND CHANNEL IMPROVEMENTS IN MILES
0
1000
2000
3000
4000
R
L
C
MAF = MILLIONS OF ACRE FEET
mi = MILES

TABLE 7.—*Regional summary of flood control projects of the Corps of Engineers within the continental United States, completed or under construction as of June 30, 1960*

Region	Reservoirs			Levees, floodwalls, and channels			Total 1st cost [1]
	Number	Capacity reserved for flood control	1st cost [1]	Length of levees and floodwalls	Length of channel improvement	1st cost [1]	
		Millions of acre-feet	*Millions of dollars*	*Miles*	*Miles*	*Millions of dollars*	*Millions of dollars*
New England	27	1.06	176.3	32.6	18.8	38.6	214.9
Middle Atlantic	13	1.76	95.7	104.6	46.0	126.1	221.8
South Atlantic	5	7.13	26.5	801.4	545.0	312.6	339.1
Lower Mississippi	7	5.17	93.1	3,370.7	4,399.7	1,332.0	1,425.1
Gulf Southwest	17	7.76	220.1	305.0	160.3	119.1	339.2
Arkansas-White-Red	34	19.79	535.1	693.5	435.0	91.6	626.7
Ohio (minus Tennessee)	46	11.20	615.0	264.6	71.4	210.3	825.3
Tennessee Basin	------	------	------	------	2.5	.7	.7
Upper Mississippi	7	3.27	95.6	996.4	85.3	305.8	401.4
Great Lakes	2	.36	27.6	7.3	43.8	25.8	53.4
Red River of the North	4	1.04	3.9	1.9	215.8	9.0	12.9
Missouri	14	20.64	348.4	725.9	902.9	422.1	770.5
Colorado	5	2.53	26.7	1.0	6.0	.7	27.4
Great Basin	0	0	0	15.5	36.6	5.1	5.1
Central Valley	15	2.72	134.0	1,267.5	52.1	227.8	361.8
California coastal	11	.42	96.8	91.4	276.7	269.4	366.2
Columbia	12	1.97	151.4	349.6	114.1	49.9	201.3
North Pacific coastal	2	.21	42.9	19.0	18.0	6.0	48.9
Total, continental United States	219	87.03	2,689.1	9,047.9	7,430.0	3,552.6	6,241.7

[1] This cost includes funds already expended plus the estimated cost of completing those projects under construction as of June 30, 1960. Only costs allocable to flood control are included. Includes non-Federal costs where known.

TABLE 8.—*Regional summary—Flood control projects of the Corps of Engineers authorized but not started as of June 30, 1960*

Region	Reservoirs			Levees, floodwalls, and channels			Total 1st cost
	Number	Capacity reserved for flood control	1st cost	Length levees and floodwalls	Length channel improvement	1st cost	
		Millions of acre-feet	*Millions of dollars*	*Miles*	*Miles*	*Millions of dollars*	*Millions of dollars*
New England	6	0.13	47.3	3.0	1.4	34.4	81.7
Middle Atlantic	11	.97	225.0	6.0	13.1	18.2	243.2
South Atlantic	1	.02	3.4	4.5	488.5	26.1	29.5
Lower Mississippi	2	.29	12.3	------	892.5	3.7	16.0
Gulf Southwest	7	2.03	146.2	------	122.7	31.2	177.4
Arkansas-White-Red	20	11.09	313.6	10.0	88.1	2.7	316.3
Ohio (minus Tennessee)	26	4.64	590.8	603.4	77	207.2	798.0
Tennessee [1]	------	------	------	------	------	------	------
Upper Mississippi	9	3.70	179.9	508.2	87.0	97.2	277.1
Great Lakes	------	------	------	34.7	120.0	43.9	43.9
Red River of the North	------	------	------	------	56.6	1.0	1.0
Missouri	26	8.35	422.8	1,411.1	40.1	187.8	610.6
Colorado	1	.32	10.8	------	94.0	6.4	17.2
Great Basin	3	.23	10.9	5.0	22.0	1.2	12.1
Central Valley	3	2.08	137.8	353.5	6.0	4.4	142.2
California coastal	1	.08	2.4	18.6	146.5	9.8	12.2
Columbia	5	5.57	179.7	119.4	1,034.9	94.3	274.0
North Pacific coastal	------	------	------	------	6.0	1.6	1.6
Alaska	------	------	------	6.5	------	11.9	11.9
Hawaii	------	------	------	------	2.5	1.6	1.6
Total	121	39.50	2,282.9	3,083.9	3,299.5	784.6	[2] 3,067.5

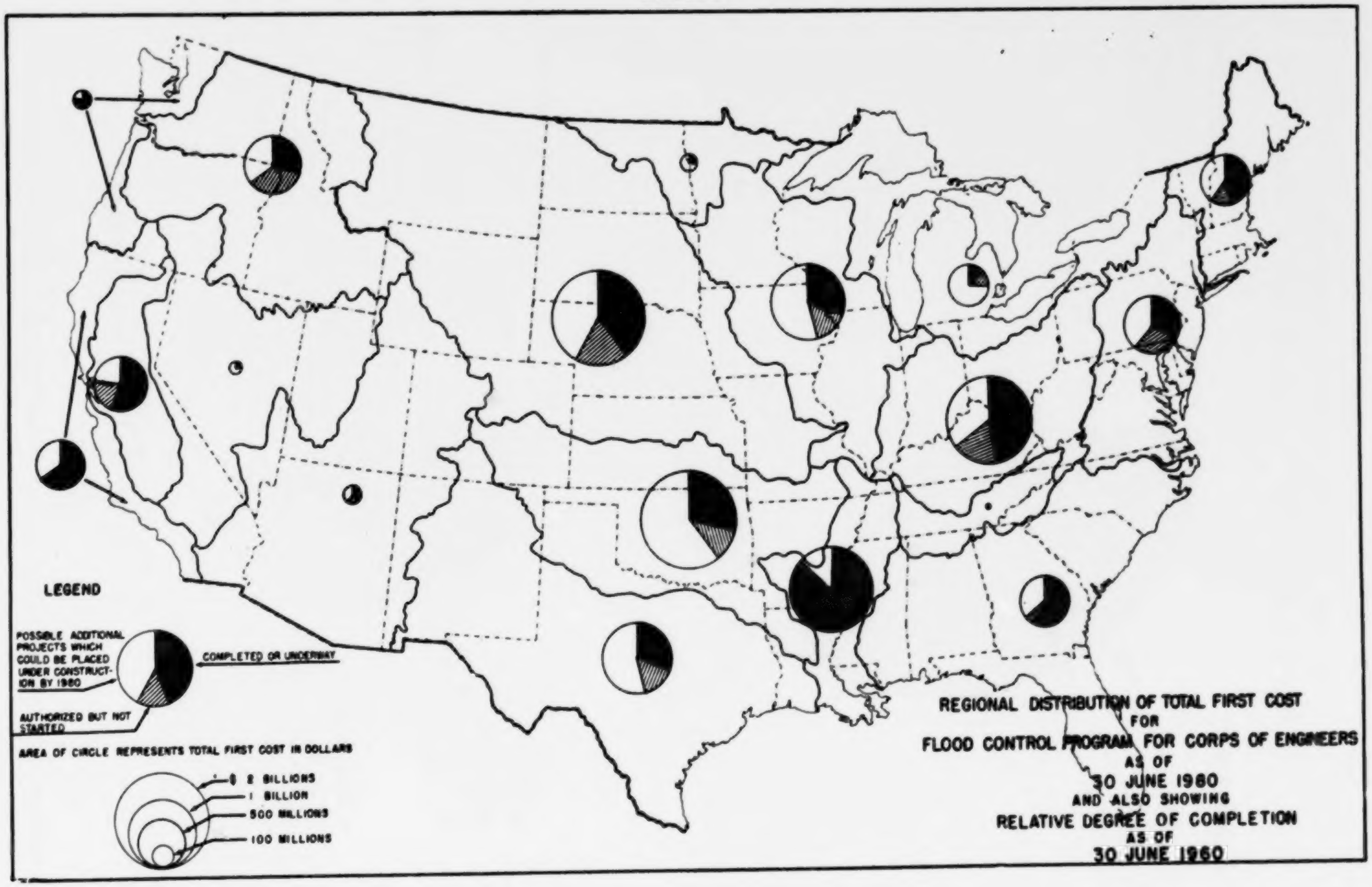
[1] Does not include projects of the Tennessee Valley Authority.
[2] Includes about $994 million for authorized projects which have been classified as "deferred for restudy."

AUTHORIZED PROJECTS, NOT STARTED

Authorized projects considered active, but for which construction funds have not yet been made available, are listed separately in supplement C, and are shown on the maps (figs. 3A and 3B).

The total estimated Federal cost of these authorized flood control works which have not yet been started is about $3.07 billion. This program would provide about 40 million acre-feet of flood control storage in 121 reservoirs, 3,000 miles of levees and floodwalls, and 3,300 miles of channel improvement. The geographic distribution of this program by major river basins or regions is shown on table 8, and graphically on figure 4.

FIGURE 5

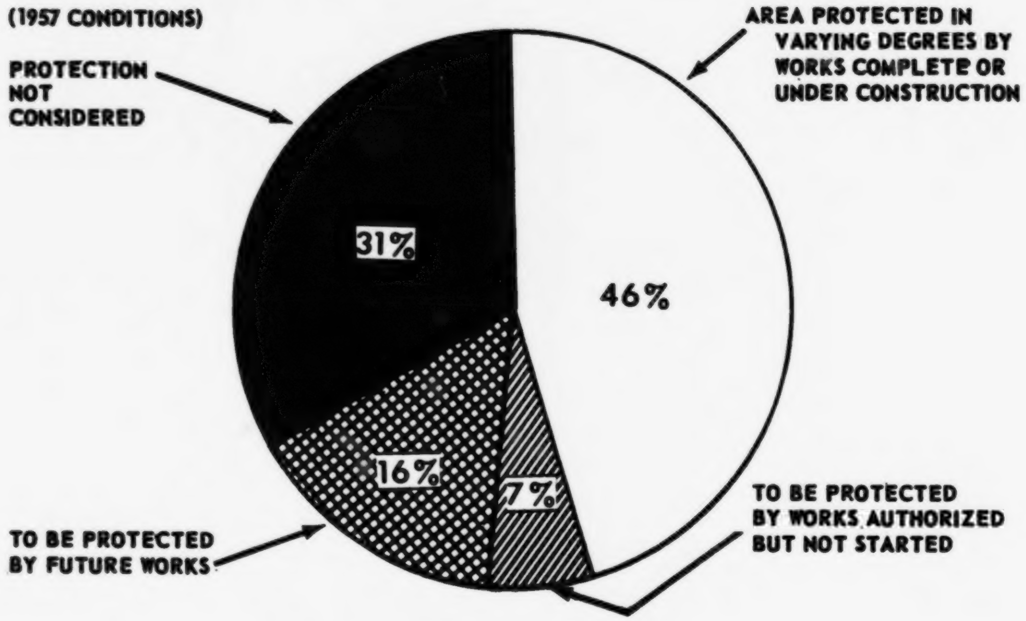


REGIONAL DISTRIBUTION OF TOTAL FIRST COST
FOR
FLOOD CONTROL PROGRAM FOR CORPS OF ENGINEERS
AS OF
30 JUNE 1980
AND ALSO SHOWING
RELATIVE DEGREE OF COMPLETION
AS OF
30 JUNE 1960

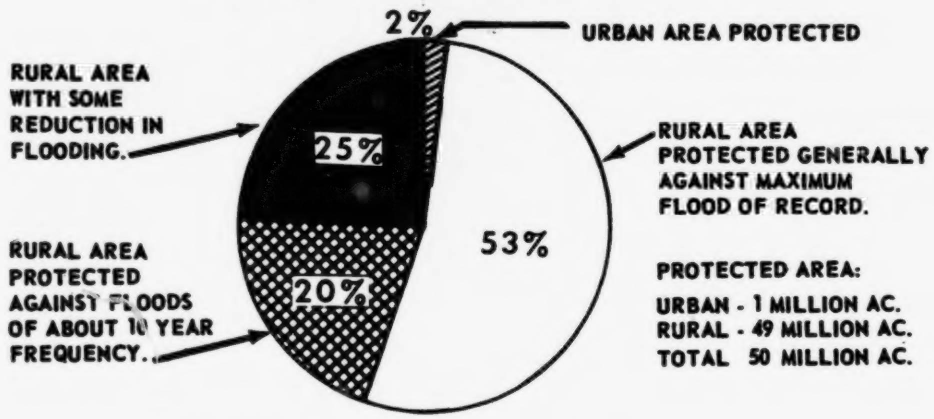
LEGEND
POSSIBLE ADDITIONAL PROJECTS WHICH COULD BE PLACED UNDER CONSTRUCTION BY 1980
COMPLETED OR UNDERWAY
AUTHORIZED BUT NOT STARTED
AREA OF CIRCLE REPRESENTS TOTAL FIRST COST IN DOLLARS
$ 2 BILLIONS
1 BILLION
500 MILLIONS
100 MILLIONS

FIGURE 6

STATUS OF FLOOD CONTROL ON PART OF FLOOD PLAIN STUDIED – ABOUT 109 MILLION ACRES



A. STATUS OF TOTAL FLOOD PLAIN



B. STATUS OF AREA PROTECTED BY WORKS COMPLETE OR UNDER CONSTRUCTION

(1) Includes consideration of some work by other Federal Agencies and by non–Federal agencies.

SUMMARY

The geographic distribution of the total authorized flood control, together with future work (sec. VII) is presented graphically on figure 5.

In terms of appropriations through fiscal year 1960 the authorized program (works complete or under construction and works authorized but not started) is about 43 percent complete. As shown on figure 6 works complete or under construction now provide flood protection in varying degrees to about 46 percent of the total flood plain inventoried by the Corps of Engineers. Figure 6 also summarizes in general terms the degree of flood control that has been provided in the protected area. It will be noted that a flood problem still exists in areas which now have a relatively low degree of protection as well as in the large unprotected areas that remain.

SECTION VI—FLOOD CONTROL WORK UNDER CONTINUING AUTHORITIES

The great majority of the projects undertaken by the Corps of Engineers in the interest of flood-damage reduction are individually authorized by act of Congress. But as pointed out in the general discussion of legislative authorities (sec. III) the Congress has made it possible for the corps to undertake minor projects without specific congressional authorization. The continuing authorities permitting this type of work are—

1. Public Law 685, 84th Congress, which authorizes the Secretary of the Army to approve projects that can be completed at a Federal expenditure of less than $400,000. Total expenditures under this act in any year cannot exceed $10 million.
2. Section 208 of the Flood Control Act of 1954, which authorizes clearing and snagging projects to reduce flood damages, with the limitations that the amount to be expended for any single tributary during any one year shall not exceed $100,000, and that no more than $2 million may be spent for this work throughout the Nation in any one year.
3. Section 14 of the Flood Control Act of 1946 which authorizes emergency bank-protection work to prevent flood damage to highways, bridge approaches, and public works. The amount to be spent an any one locality may not exceed $50,000, and no more than $1 million may be expended in the aggregate during a single year.

The number and cost of projects completed, or under construction, as of June 30, 1960, pursuant to Public Law 685, is presented in table 6. It will be noted that in the aggregate Public Law 685 projects authorized to date will cost less than $14 million, and that this amounts to only about two-tenths of 1 percent of the total cost of flood control projects, completed or under construction, which have been authorized individually by act of Congress.

Snagging and clearing work undertaken by the Corps pursuant to section 208 of the Flood Control Act of 1954 had required the expenditure of about $13.9 million by June 30, 1960.

For emergency bank-protection work under section 14 of the 1946 act the sum of $6.2 million had been expended by June 30, 1960.

EMERGENCY FLOOD CONTROL ACTIVITIES

In addition to planning and constructing the flood-control projects previously discussed, the Corps of Engineers extends assistance to those endangered by an expected major flood, and to those suffering flood damages. Authority for such assistance was first provided for the tributaries of the Mississippi River by the act of June 15, 1936. In 1941 authority for such work was extended to the entire Nation. This legislation was amended and supplemented in 1946, 1948, and 1950. The current legislative base for such work is Public Law 99, 84th Congress, approved June 28, 1955. This act authorizes an "emergency fund" of $15 million to be used for (*a*) "flood emergency preparation"; (*b*) "flood fighting and rescue operations"; and (*c*) the "repair or restoration of any flood control work threatened or destroyed by flood." The annual replenishment of this fund by appropriations is authorized.

Expenditures for emergency operations under Public Law 99 and section 9 of the 1936 act, are summarized in table 9. The average annual cost of such work during the 9-year period 1951 to 1959, inclusive, amounts to about $11.2 million.

Table 9.—*Flood emergency expenditures of the Corps of Engineers under Public Law 99 and sec. 9 of the act of June 15, 1936, fiscal years 1951 through 1959*

[Millions of dollars]

Fiscal year	Authority for expenditure		Total
	Public Law 99	Sec. 9	
1951	5.91	0.15	6.06
1952	15.47	.24	15.71
1953	34.42	.51	34.93
1954	2.81	.11	2.92
1955	1.25	.30	1.55
1956	13.69	.10	13.79
1957	8.03	.03	8.06
1958	7.93	.03	7.96
1959	10.11	.01	10.12
Total	99.62	1.48	101.10

In addition to the emergency work described above, the Corps of Engineers participates in the broad Federal program authorized by the Federal Disaster Act of 1950. Work under this act must be specifically authorized at the time by the Office of Civil Defense and Mobilization, after the President has declared that a major disaster has occurred. Funds for this work are not appropriated directly to the Corps of Engineers. The first disaster relief work performed by the Corps of Engineers under Public Law 875 followed the great flood of July 1951 in the Kansas River Basin and adjacent portions of the Missouri River Basin. This flood resulted in the inundation of about 2,250,000 acres of land and parts of 186 towns and cities. The most spectacular damage was at Kansas City. The work performed pursuant to Public Law 875 by the Corps of Engineers cost over $2.7 millions. This covered only a part of the costs incurred by the Corps for flood fighting, rescue operations, and the repair and restoration of public facilities during this flood.

Another outstanding example of corps participation in flood fighting and relief work occurred during and following the floods of August and October in the northeastern United States. This work, designated "Operation Noah," cost a total $34.5 millions. In this operation the corps directed the restoration of about 75 water and sewer systems, cleared stream channels at more than 200 locations, made emergency repairs to 28 dams, repaired roads and bridges, and performed related work. Participating in Operation Noah were 608 officers and civilians of the Corps of Engineers drawn from many parts of the Nation. Contractors performing actual work employed over 3,300 men and used over 1,400 pieces of heavy equipment.

Section VII—Future Flood Control Program

The magnitude of the flood problem in the United States indicates clearly that it is one of the major factors in any approach to the optimum control and use of our water resources. All evidence points to an increase in flood damage as our river valleys are developed and used. This increase in damage is proceeding, at least in some areas, more rapidly than it has been possible to reduce it by provision of engineering works. Moreover, flood control works, particularly reservoirs for storage of floodwaters, generally fit in well with plans for comprehensive river basin development.

OBJECTIVES

In view of this situation it is necessary to reexamine the objectives of Federal flood control activities in order to present the broad outlines of a future flood control program. To do this the Corps of Engineers initiated in 1957 a nationwide inventory of flood problems and of measures that might be undertaken to meet them for the foreseeable future, or by 1980.

In approaching this problem realistically it has been recognized that it will not be physically or economically feasible within the foreseeable future to eliminate all flood damage. This would probably hold true even without the present accelerated development of flood plains. Consequently, the general goal accepted was that river valleys should be provided with a degree of protection which, in combination with provisions for necessary water uses, would permit a reasonable degree of development without excessive flood damage on an average annual basis, and without creating a false sense of security which would encourage unwise development and set the stage for future flood disasters.

ASSUMPTIONS

Certain general governing factors or assumptions were considered. The increase in potential flood damage, described in section I, which would occur if nothing further was done to control floods or adjust flood plain use to the flood hazard, was recognized. It was felt that the estimate of increase in flood damage resulting from further flood plain development was probably on the conservative side. The increasing need of industry for water and for low-cost water transportation will inevitably lead to continuation of the trend of industry to seek riverbank locations. River valleys are perhaps becoming less important as new routes of land transportation but many such routes are already established in river valleys and will continue to be used. The interest in use of flood plain lands for agricultural purposes will probably increase rather than diminish, even though this may not be in accord with the most economical means of meeting in all areas the Nation's need for agricultural products. These factors all point to an increasing need and demand for works and measures to reduce flood damages.

On the other hand it has been assumed that during the next two decades increasing attention will be paid by States and municipalities to regulation of flood plain use to avoid the creation of future flood hazards, and serve as a guide to proper use of flood plains.

There is a physical and economic limit to the works that can be provided to control floods. Essential development in river valleys will in some cases preclude or make uneconomic the construction of levees, flood walls, and adequate channels. Feasible natural sites for storage of floodwaters are limited. In many cases reservoir sites which have been considered for flood storage are now being preempted by other developments, and this trend is bound to continue. Furthermore, it seems inevitable that there will be conflict in demands for limited storage space, and it is quite possible that storage space needed to handle future floodflows may have to give way before the primary need for water supply.

While storage of floods for reduction of flood damage is not in itself a consumptive use of water, the need for flood control may in some cases find itself in competition for the the storage space needed for water supply. In some situations, as in river valleys of the West with their generally predictable snowmelt floods, the same storage space in a reservoir can be used with assurance for both flood control and water supply.

Character and scope.—The program for reduction of future flood damages must embrace all feasible solutions of the flood problem. The possibilities of slowing down the creation of future flood hazards are presented in a subsequent section of this study. The future flood problem to be solved is based upon the assumption that to a reasonable degree action will be taken to adjust flood plain use to the flood hazard. Even if this part of the objective is attained, any major reduction of potential flood damage will depend upon flood control works. It is necessary, therefore, to know to what extent the Nation can depend upon storage reservoirs, levees, floodwalls, and channel improvements to reduce anticipated flood losses.

The 1957 inventory and estimate of the Corps of Engineers attempted to forecast the general character and distribution of flood control works which would be required to meet the need and might be found justified by 1980, and to estimate the order of magnitude of costs that would be involved.

In broad outline it appears that necessary future work will include additional levees and floodwalls for flood plain areas that have experienced urban and industrial development; improvement of flood channels for reduction of damage in agricultural areas, and to provide major outlets for land drainage, and a large amount of additional flood storage capacity. The future program would be in addition to the Federal flood control work now complete or under construction. It includes the improvements authorized but not started which are summarized in section V of this report.

In making this broad forecast of the extent of flood control improvements that would be required to effect a reasonable reduction in the 1980 flood damage potential, the Corps of Engineers considered that, on the basis of past experience and present trends, some of the work would be accomplished by other Federal agencies and by States and other non-Federal entities.

This report presents in some detail only the part of this future program which is of a type normally undertaken by the Corps of Engineers under the Flood Control Acts. The nature and cost of this work is summarized below and its regional distribution is shown on table 10.

The foregoing estimate of future requirements for reduction of flood damage excludes consideration of protection against coastal flooding by hurricane-driven waters of the oceans or Gulf of

TABLE 10.—*Regional summary of possible future flood control projects which might be constructed by the Corps of Engineers*

Region	Reservoirs			Levees, floodwalls, and channels			Total 1st cost [1]
	No.	Capacity reserved for flood control	1st cost [1]	Length levees and floodwalls	Length channel improvement	1st cost [1]	
		Million acre-feet	*Millions*	*Miles*	*Miles*	*Millions*	*Millions*
New England	25	0.72	$176.0	22.8	35.4	$16.0	$192.0
Middle Atlantic	10	2.33	205.1	39.0	36.0	81.5	286.6
South Atlantic	64	4.20	159.2	43.1	100.0	47.0	206.2
Lower Mississippi	2	.48	15.0	314.4	1,456.2	211.4	226.4
Gulf Southwest	42	11.64	444.8	223.0	200.0	148.0	592.8
Arkansas-White-Red	66	8.82	979.0	382.0	510.0	324.0	1,303.0
Ohio	54	5.10	514.9	22.8	370.0	104.7	619.7
Upper Mississippi	51	5.26	381.3	812.0	487.0	335.4	716.7
Great Lakes	6	.45	17.9	154.0	395.0	273.3	291.2
Red River of the North	4	.28	11.0	21.0	192.0	26.3	37.3
Missouri	20	11.10	490.0	1,533.0	1,158.0	311.0	801.0
Colorado	1	.09	2.0	105.0	64.0	26.6	28.6
Great Basin	4	.38	19.0	33.5	43.5	7.7	26.7
Central Valley	10	1.03	51.5	258.0	170.0	104.6	156.1
California coastal	10	1.19	28.6	74.0	244.0	168.7	197.3
Columbia	13	10.23	155.5	211.0	283.0	88.1	243.6
North Pacific coastal	16	.80	10.5	28.0	40.0	5.2	15.7
Total continental United States	398	64.10	3,661.3	4,276.6	5,884.1	2,279.5	5,940.8

[1] Costs allocable to flood control. Include estimated non-Federal costs. Does not include possible works for protection against coastal flooding.

Mexico. As indicated in the discussion of solutions of the flood problem in section II of this report there are serious difficulties in providing for protection of coastal areas which would be in accord with requirements for development and use. It seems possible, however, that protection of some coastal areas will be necessary and feasible. In some cases this can be accomplished in connection with projects for control of beach erosion. In others, where topography permits, protection will be only against storm-driven tides. It seems probable that projects for protection against hurricane-driven coastal floods may total at least $500 million in cost during the next two decades.

A summary of flood control improvements under construction and authorized but not yet started is given in section V. The future flood control program would therefore consist of the following:

	Billions
a. Required to complete work now under construction	$1.9
b. Completion of work authorized but not started [1]	3.1
c. Future work:	
Rivers	6.0
Coastal	0.5
Total	11.5

[1] This does not include flood-control works with an estimated cost of $300,000,000 authorized by the act of 1960. Inclusion of this authorization would reduce the total additional future work and increase the work authorized but not started. The grand total would be unchanged.

The regional distribution of the future flood-control program, as well as the cost relative to the presently authorized program, is indicated by figure 5.

From the viewpoint of comprehensive water resources development the most important means of dealing with the future flood problem is the reduction of stage and damage by storage of floodwaters. The following table shows the amount of storage reserved for flood control in reservoirs of the existing Federal program and of the future program discussed in this report:

	Million acre-feet
Reservoirs completed and under construction	87
Reservoirs authorized but not started	40
Future storage required	64
Total	191

To an increasing degree a flood control program designed to meet the needs of the foreseeable future must be planned and carried out as a part, and a major part, of a multiple-use program aimed at complete control and use of the resources of each river basin. The specific requirements will vary by regions and by river basins and must be planned to fit those needs. The data presented, however, provide a general basis for estimating what may be accomplished in the future to prevent an increasing toll of flood damage.

SECTION VIII—EFFECT OF FLOOD CONTROL PROGRAMS

This section of the report presents an appraisal of the effect of the existing flood control program in reducing flood damages, and of the reduction in the flood damage potential that may be accomplished by a future program.

REDUCTION OF DAMAGE BY EXISTING WORKS

As stated previously in this study the reduction of flood damage creditable to a project in determining its economic justification is the difference between the flood damage that would have occurred without the project and that actually experienced with the project in being. To this may be added properly any increase or change in land use, or enhancement of land values, which may result from protection of the flood plain. The sum of these two direct benefits, plus any indirect or associated benefits which may accrue within or without the flood plain, represents the total benefit creditable to a flood control project. This is the benefit which is compared with cost to determine whether a project would result in a new increase in the Nation's wealth and is economically justified.

When flood protection has been provided by local works, or by adequate reservoir control, the protected flood plain area usually develops very rapidly. For example, industrial and other development in protected parts of the Mississippi and Ohio Valleys has been phenomenal. After this development has taken place, the damages that would be suffered if the protective works did not exist, or if they failed, would be much greater than if they had never been constructed. Some development would have taken place in the absence of the project but it would have been less extensive.

From an economic standpoint a part of the overall benefit which results from protection of a developed area is creditable to the investment made in developing the flood plain, rather than to the project. Nevertheless, the amount of damage that would be suffered under present conditions in a protected area, if the protection did not exist or was to fail, is a significant measure of the current effectiveness of a flood control project. Moreover, it is the only measure of effect which may be obtained simply after a project is constructed.

Gross damage prevented.—For these reasons the Corps of Engineers regularly estimates the damages that have been prevented, under the existing degree of flood plain development, for major flood control projects after each important flood. The figure thus obtained will be referred to as the "gross damage prevented," to distinguish it from benefits creditable solely to the flood control improvements. These estimates of "gross damage prevented" made over the period of years since 1918 add up to about $9 billion, without bringing the estimates to a common dollar value. Of this amount $6 billion in gross damage prevented has occurred in the alluvial valley of the Mississippi River.

Annual gross damage prevented.—The total estimate of gross damage prevented by works of the Corps of Engineers represents a benefit of about $200 million annually on the average for the 42-year period during which the flood control program was started and grew in effectiveness, and during which the protected areas developed to their present state.

Estimates assembled by the Corps of Engineers to show the current average annual value indicate that with present (1957) development of river valleys, and on the theoretical basis that all flood control works did not exist, the average annual flood damage in the United States would be increased by about $610 million. Of this amount about $497 million is prevented by works of the Corps of Engineers and about $113 million by works of other Federal agencies and by non-Federal works. As time goes on and protected areas are even more intensively developed, the annual gross flood damage prevented could become much greater and be far in excess of any annual benefits that could have been credited to a project for purposes of economic evaluation.

Thus, the estimate of gross flood damage prevented is useful as a measure of the current effectiveness of flood control projects in preventing flood damage, plus their effectiveness in bringing about development of flood plain areas.

This point has been presented in some detail since confusion has resulted in the past from the fact that estimates of gross flood damage prevented have become so large as to make it appear that the flood problem in the United States has been virtually eliminated. This is far from the case.

REDUCTION OF DAMAGE BY FUTURE PROGRAM

The future flood damage potential has been estimated in section I of this report. This showed following flood damage potential for the area included in the inventory made by the corps:

[In millions of dollars annually]

	Conditions	
	1957	1980
Downstream potential	538	739
Upstream potential	160	221
Total	698	960

Since the inventory by the corps did not cover all areas of potential upstream damage, an effort was made to approximate the total upstream damage to give some indication of the total flood damage potential by 1980, with the following result:

[In millions of dollars]

	Conditions	
	1957	1980
Downstream potential	538	739
Upstream potential	417	574
Total	955	1,313

This section deals in detail only with the area inventoried by the corps, which includes about 38 percent of the upstream area subject to some flood damage, and with the effect of future works and measures of the type normally provided by the Corps of Engineers under the flood control laws.

As indicated previously the rather large proportion of "upstream" damage is not fairly representative of the relative magnitudes of upstream and downstream flood problems. Much of the original downstream flood damage potential has been reduced by works now in operation. Furthermore, many small flood problems in upstream areas, which affect a few individuals and have little or no local or regional economic impact, may not be possible of solution by economic engineering works.

Reduction of damage by program under Corps of Engineers.—All field offices of the Corps of Engineers were asked to furnish estimates based upon their best judgment as to the effect of future projects of the future Corps program (sec.VII) in reducing the 1980 damage potential. These field results were reviewed and modified in the Office, Chief of Engineers, to show the following reductions:

	Millions
(a) By completion of corps projects under construction in 1957 but not in operation	$106
(b) By completion of corps projects authorized but not yet started	155
(c) By additional flood control works which may be feasible under future corps program	216
Total reduction for corps program	477

The major part, about 80 percent, of the reduction in flood damage potential that would be obtained by future works envisioned by the Corps of Engineers would accrue to main stem and major tributary areas, while the remainder would accrue to those areas in smaller stream basins where the corps is undertaking, or would undertake, work.

Residual damage potential.—The 1980 residual damage potential for the area inventoried by the Corps of Engineers after reduction by corps projects would be:

[Millions of dollars annually]

	Upstream	Downstream	Total
1980 potential damage	221	739	960
Reduction by Corps work	95	382	477
Total residual damage	126	357	483

Effect of other programs.—In making this estimate of damage that could be prevented by feasible future flood control works, it was recognized that additional future work would be accomplished by other Federal agencies and probably to some extent by non-Federal entities. It was not possible, however, to present in this study an estimate of such work or the reduction in potential flood damage it would produce.

As indicated previously in this report, the flood plain areas inventoried by the corps included only about 38 percent of the total upstream area that may be subject to flood damage. Thus, the part of the total flood damage potential that would not be affected by the program outlined above may be derived as follows:

	Millions
Total 1980 flood damage potential, upstream and downstream	$1,313
1980 damage potential in area inventoried by corps	969
Total unaffected	344

If nothing was done to reduce this part of the total flood damage, or if it should prove uneconomic to provide full flood protection, the total residual average annual damage potential by 1980 would be:

	Millions
Residual 1980 damage potential in area affected by corps program forecast in this report	$483
Residual in area not inventoried	344
Total residual, 1980	827

Continuation of flood control work by the Soil Conservation Service under Public Law 566 could well effect major reductions of flood damage in the upstream area not covered by the inventory made by the corps. Furthermore, the Bureau of Reclamation[9] has projected a future reclamation program that would provide a substantial amount of flood storage which would have a significant effect in downstream areas.

COST OF DAMAGE REDUCTIONS

The order of magnitude of future expenditures that will be required to obtain the reduction of future flood damages in river basins which seems feasible is as follows for work under the program of the Corps of Engineers:

	Billions
(*a*) Required after fiscal year 1960 to complete work now under construction	$1.9
(*b*) Completion of projects authorized but not started	3.1
(*c*) Completion of additional future work	6.0
Total	11.0

Continuation at present rate.—Appropriations for construction of flood control improvements are now being made at the rate of about $300 million annually. If this rate is continued over the next two decades, this would permit completion by 1980 of the present backlog of authorized work and roughly one-sixth of the additional future work estimated above. Under such a program the flood damage potential in the area inventoried by the Corps could be reduced about as follows:

[Millions of dollars annually]

	Upstream	Downstream	Total
1980 flood-damage potential	221	739	960
Reduction by completion of authorized work and about ⅙ of future work	59	238	297
Residual	162	501	663

It appears therefore that continuation of the Federal flood control programs at about the present rate of expenditure will just about keep pace with the anticipated growth of flood damage potential due to use of flood plains, as the flood damage potential under 1957 conditions is estimated at $698 million annually.

Accelerated program.—If annual appropriations for the flood-control program were increased from the present level to $500 million annually by 1970, and were to continue at that rate, this would complete the backlog of authorized work and allow the future work to be completed or placed underway by 1980. Such an accelerated program would permit the following reduction of flood damage potential for the area inventoried by the Corps:

[Million of dollars annually]

	Upstream	*Downstream*	*Total*
1980 flood-damage potential	230	739	969
Reductions	95	382	477
Residual damage	126	357	483

This level of Federal expenditure for flood control would definitely reverse the trend of increasing flood damage. Even greater expenditures would be required, however, to make a further reduction in the gross flood damage potential that would remain.

Summary.—The reductions in 1980 in flood damage potential which it seems possible to obtain by programs of varying magnitudes as described above are shown graphically on figure 7.

In brief, this figure shows that continuation of the present rate of Federal expenditures for flood control will enable flood protection to just about keep up with the increase in flood damage that may be anticipated by 1980 as a result of flood plain development over the next two decades. The flood damage potential remaining in 1980 would be almost as great as that existing at present.

An accelerated program would permit a reversal of the upward trend of flood damage and permit a material reduction of the 1980 damage potential. A substantial residual damage would remain even if all feasible protection works were provided.

These estimates are presented to indicate the order of magnitude of the task of achieving a reasonable degree of flood protection in the face of the increasing use and development of flood

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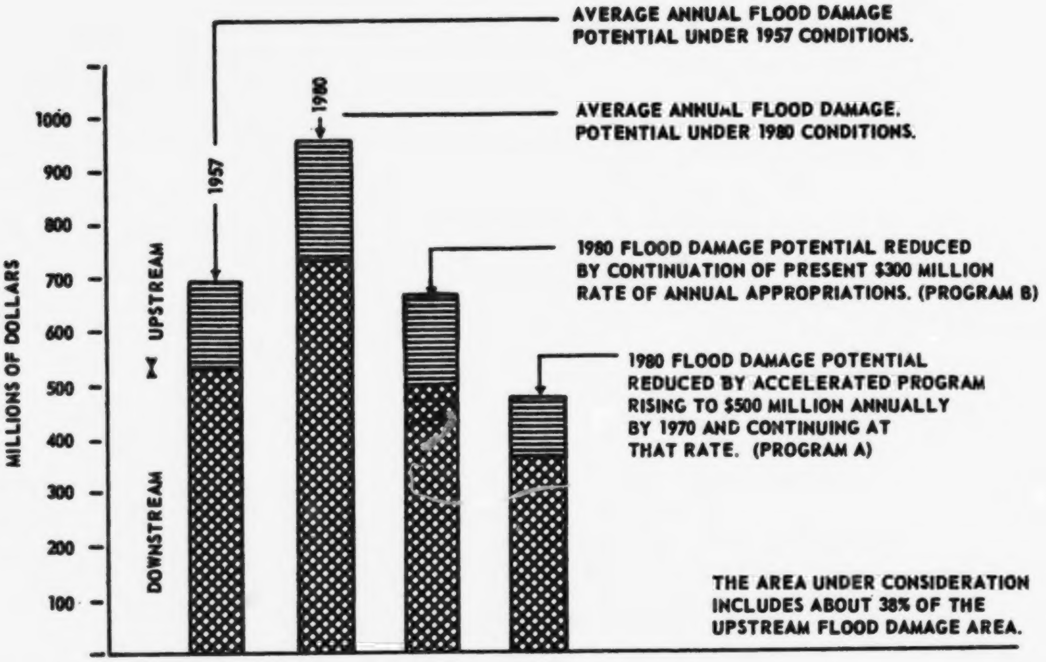
[9] "Future Needs for Reclamation in the Western States," report by Secretary of the Interior to Select Committee, Committee Print No. 14.

FIGURE 7

ESTIMATED EFFECT OF POSSIBLE FUTURE FLOOD CONTROL PROGRAM IN REDUCING 1980 POTENTIAL FLOOD DAMAGE



plains which may be anticipated during the next two decades.

These conclusions emphasize the need for action over the next two decades to regulate flood plain use so as to avoid to the extent possible the creation of new flood problems and damages, and to reduce the necessity for Federal expenditures for flood protection.

SECTION IX—RELATIONSHIP TO OTHER PHASES OF WATER RESOURCES DEVELOPMENT

This section of the report is designed to show the multiple-purpose nature of the Federal flood control program and how it is related to other phases of water resources development.

HYDROELECTRIC POWER

There has been a continuing growth of Federal interest in the development of hydroelectric power as a function of projects for river basin development.[10] Consideration of hydroelectric power in this report is based upon the increasing recognition of the multiple-purpose concept of river basin development and the important part that hydroelectric power plays in that development.

Existing program.—The lists of projects authorized by Congress under the Flood Control Acts presented in this report as supplement C include those multiple-purpose projects which include development of hydroelectric power as a function. This part of the existing civil works program may be summarized as follows:

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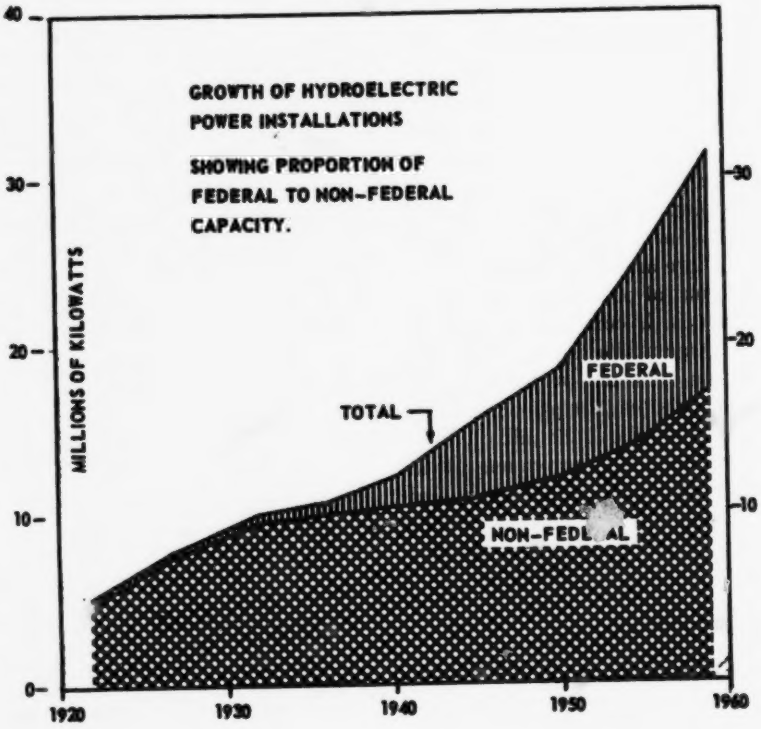
[10] An excellent review of legislative developments which have marked the growth of Federal interest in hydropower is given in vol. 3, "Water Resources Law," report of the President's Water Resources Policy Commission, 1950.

	Estimated cost (in millions of dollars)		Installed capacity (in thousands of kilowatts)
	Total cost	Cost allocated to flood control	
Complete	1,019	356	2,032
Under construction	2,155	396	3,623
Authorized, not started	491	184	685
Total	3,665	936	6,340

Since 1913 the Corps of Engineers has been required by law to include in its survey reports information regarding the possibilities of development of hydroelectric power. Prior to the early 1930's, however, there was relatively little active Federal construction of hydroelectric projects. Since passage of the original Flood Control Act of 1936, and subsequent Flood Control Acts, there has been a large increase in development of generating capacity in connection with river development projects. Figure 8 herewith shows the extent to which Federal generation of power has increased. Published information on the Nation's total hydroelectric generating capacity as of December 1959 may be summarized as follows:

	Kilowatts
Non-Federal developments	17,469,000
Federal development:	
Corps of Engineers	6,297,000
TVA	2,746,000
Bureau of Reclamation	5,139,000
Other	49,000
Total Federal	14,231,000
Grand total	31,700,000

FIGURE 8



SOURCES:
STATISTICAL ABSTRACTS OF DEPT. OF COMMERCE.
PUBLICATIONS OF FEDERAL POWER COMMISSION.

The Nation's total generating capacity in 1959 amounted to about 174 million kilowatts. Thus, hydroelectric capacity accounts for about 18 percent of the total. The remainder is carried by thermal installations.

It will be noted that a large portion of the hydroelectric capacity provided by the Corps of Engineers has been in connection with projects authorized under the flood control program.

Future program.—The future requirements of the United States for generation of electric energy have been estimated in a report submitted by the Federal Power Commission to the select committee. The estimates of needs for future generating capacity given from various sources[11] varied from about 450 million kilowatts to over 500 million kilowatts required by 1980. Estimates by the FPC as of 1957 show the total hydroelectric power potential of the country as about 117 million kilowatts of which about 23 percent has been developed, with about 91 million kilowatts remaining undeveloped.

It seems obvious, therefore, that principal reliance must be placed upon thermal power to meet the heavy demands forecast for 1980. Hydropower, however, can contribute to meeting this demand. In this study, therefore, an effort was made by the Corps of Engineers to estimate the amount of power that might be developed in connection with future river developments needed for navigation and flood control. There are many factors which will influence the amount of power that can be developed in connection with comprehensive river improvement plans. One major factor will be the increasing competition by other water uses for relatively scarce storage sites. It appears, however, that development of about 22 million kilowatts of additional capacity may prove feasible in connection with future plans for flood control and navigation. The great majority of this would result from the future flood control program described in this study.

DRAINAGE

Reclamation of land by drainage in the United States has in past years been essentially a non-Federal activity accomplished largely by drainage districts or by county and township drainage projects organized under State laws. As of 1950 it was reported[12] that there were 102.7 million acres of land in these drainage enterprises. Federal participation in this work has been limited, until recent years, to the relatively small amount of drainage provided in connection with Federal irrigation projects in the West, and to the major drainage outlets provided by the Corps of Engineers under the flood control program.

The drainage problem in the United States is not confined to the flood plains of rivers, but there is an intimate relationship between the need for flood control and drainage on much of the flood plain. The Corps of Engineers has estimated that about 109 million acres, or over 5 percent of the land area of the United States, lies in the flood plains of rivers and streams. The proportion of flood plain land, however, varies greatly by river basins and regions.

The flood control works now complete or under construction provide or will provide flood protection in varying degrees to about 49 million acres of rural lands. By far the greater part of this protection is provided by works under the jurisdiction of the Corps of Engineers. Almost half of the protected rural area lies in the alluvial valley of the Mississippi River.

The status of this protected land and of that which may be protected by future flood control work with respect to agricultural use and need for drainage was determined by a rough appraisal by the Corps of Engineers in 1957, as follows:

[*Millions of acres*]

	Complete or under construction	Future work[1]
Agricultural status:		
Cleared and suitable for agriculture	27.5	13.5
Suitable for agriculture when cleared	9.9	6.2
Not suitable for agriculture	9.6	3.1
Not classified	2.0	1.4
Total	49.0	24.2
Drainage status:		
No drainage problem	19.7	13.7
Drainage works provided	13.1	6.5
Drainage required	16.2	4.0
Total	49.0	24.2

[1] Includes projects authorized but not started and future work.

This status is shown graphically on figure 9.

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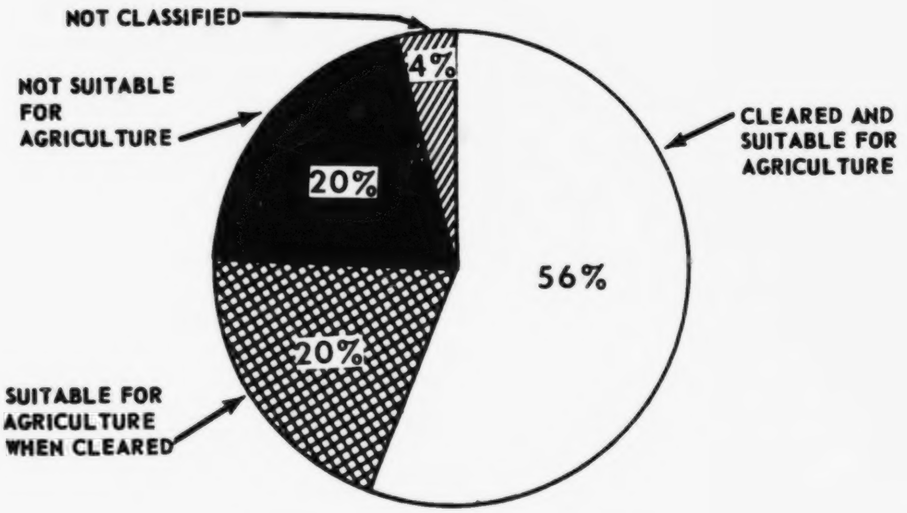
[11] "Electric Power in Relation to the Nation's Water Resources." Committee Print No. 10.

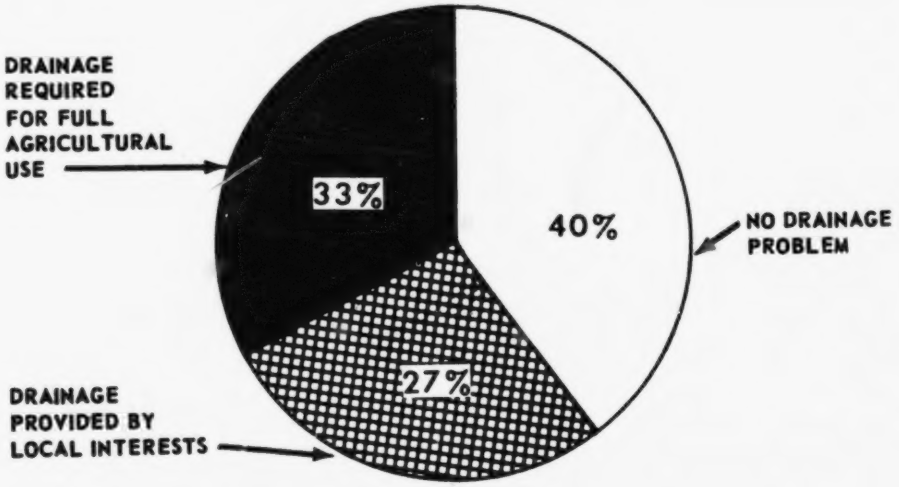
[12] U.S. "Census of Agriculture," Department of Commerce, 1950.

FIGURE 9

STATUS OF RURAL LAND IN FLOOD PLAIN AREAS
PROTECTED BY FLOOD CONTROL WORKS COMPLETE OR UNDER CONSTRUCTION
(49 MILLION ACRES)



A. STATUS FOR AGRICULTURAL USE.



B. DRAINAGE PELATIONSHIP

It will be seen that drainage has been provided on a large part of the flood plain within protected areas and also within the area that may receive protection in the future. Flood control works or major drainage outlets provided by the Corps of Engineers have contributed to this work, but it has been accomplished by non-Federal interest.

As indicated above some additional drainage improvement will be required for full agricultural use of flood plain lands that have been or will be protected from overflow. A substantial part of the area, however, amounting to about 22 percent or some 16 million acres, of the protected flood plain area is not suitable for agricultural use or not classified. Since drainage works have been provided by local interests for part of the protected flood plain area where presumably drainage was most feasible and economical, it is probable that areas still requiring drainage and those not suitable for agricultural use overlap to a major extent. As a rough approximation it is estimated that not more than 5 million acres of the 20.2 million acres of flood plain lands that will require drainage will actually be found suitable for improvement by drainage.

Water use.—Drainage improvements naturally do not involve a consumptive use of water in the way that is required by land reclamation by irrigation. On the other hand the drainage and particularly the overdrainage of large wet areas may have an adverse effect upon the overall water supply by expediting runoff and the lowering of ground water levels. The extent of this effect upon adjacent areas is not understood sufficiently at this time to be measurable in quantitative terms. In some coastal areas, for example, drainage of interior flatlands has lowered the head of fresh water to permit intrusion of salt water into aquifers. In other cases ground water levels in the drained land itself have been lowered to an extent which is unfavorable for crop production. Accordingly, the present day concept of reclamation of wetlands is one of "water control" rather than drainage per se. In any event any large scale drainage activity must involve a careful consideration of possible adverse effects upon water supply. Furthermore, there is a growing interest in the preservation of wetlands in their natural condition as habitat for fish, game, and wildfowl which deserves serious consideration.

IRRIGATION

The relationship between flood control and storage of water for reclamation of western lands by irrigation has been recognized for many years. The practical need for coordination of Federal programs for flood control and irrigation arose with passage of the first general flood control act in 1936, as that act authorized Federal flood control projects and surveys in the Western States as well as in the more humid East. As a result of subsequent authorizations both the Corps of Engineers and Bureau of Reclamation have been involved in planning and constructing multiple-purpose river basin developments in the West.

This need for coordination received legislative attention in the Flood Control Act of 1944 which provided a general basis for coordination between the Departments of Army and Interior and provided a number of specific requirements. In addition, over the years since that time agreements have been reached between the two agencies as to division of responsibilities in various areas—notably, the Missouri, Sacramento-San Joaquin, middle Rio Grande, and Columbia River Basins.

A number of flood control reservoirs authorized by Congress for construction by the Corps of Engineers[11] provide storage useful for irrigation, either on a seasonal joint use basis or as a definite allocation of storage space to irrigation. At the present time flood control reservoirs of the flood control program complete or under construction will provide about 4.9 million acre-feet of storage for irrigation, or over 5 percent of the total Federal irrigation storage provided. Of this amount, about 1 million acre-feet is exclusive reservation for irrigation and the remainder is joint use storage. This does not include the conservation storage in the large multiple-purpose reservoirs on the main stem of the Missouri which have been constructed by the Corps of Engineers under the flood control program, but will be used in part for irrigation.

Repayment arrangements for irrigation storage space in multiple-purpose projects of the Corps of Engineers are normally handled by the Bureau of Reclamation under reclamation law. In past years certain projects were authorized by Congress with varying provision for repayment.

In preparing the future flood control program outlined in section VII an effort was made to determine the general possibilities of including storage for irrigation. It is not possible to determine for any long period of the future just what agency will construct any given projects. However, on the basis of the anticipated flood problem and past experience, it seems probable that about 9 million acre-feet of storage useful for irrigation can be provided in reservoirs that may be built by the Corps of Engineers in connection with a future flood control program.

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[11] See sec. XI for flood control work of Bureau of Reclamation.

WATER SUPPLY

Legislative authority.—The Federal concern with water supply in connection with river basin development may be said to have begun with the reclamation acts. While these were aimed originally at development of the West by reclaiming lands by irrigation, they were broadened subsequently to include authority for provision of municipal and industrial water in connection with irrigation projects. Until very recently (in 1958) the authority available to the Corps of Engineers to provide for water supply for municipal and industrial use was limited to two general authorities:

(*a*) Provisions of the Civil Functions Appropriations Act of 1937 permitted the addition of water supply storage to a project if requested by water users and at their expenses.

(*b*) The Flood Control Act of 1944 provided that surplus storage space in flood control reservoirs could be sold to water users under repayment arrangements prescribed by the Secretary of the Army.

Also in a number of cases prior to 1958 the Corps of Engineers included provisions for water supply as purposes of projects recommended for flood control and these were authorized by the Congress with specific provisions for repayment by water users. There was, however, no specific legislative directive to include municipal and industrial water supply as a purpose of river basin planning, and no authority to make provision for future water needs.

For many years prior to 1958, however, a broad Federal interest in water supply generally had been expressed through the activities of Geological Survey of the Department of the Interior in studying the availability of ground and surface waters and in publishing basic water supply data for public use. Another important expression of Federal interest has existed in the activities of the Public Health Service of the Department of Health, Education, and Welfare which provides guidance to States and municipalities in the development of water supplies and supervision of Federal laws for control and abatement of pollution.

The ability of Federal agencies to give more adequate consideration to water supply in river basin planning has been greatly improved by the Water Supply Act of 1958 (Public Law 85-500, title III). This gives the Corps of Engineers new authority, and supplements existing authority of the Bureau of Reclamation, in two basic respects:

(*a*) It provides for restudy of existing or authorized projects to determine whether they should be modified to provide for water supply; and

(*b*) It provides authority to plan for and recommend provisions for future water supply storage, even though there is no immediate user ready to pay the cost. This latter procedure is essential if scarce storage sites are to be developed to full potentialities or to be preserved to meet future needs.

The 1958 act also specifies that water users will pay for water supply storage in Federal projects over a period of time and states the procedures for repayment.

Specific reservations for water supply.—Proceeding under the limited authorities available prior to the 1958 act the Corps of Engineers has provided or is providing, in connection with reservoirs complete and under construction, over 3.5 million acre-feet of storage for municipal and industrial water supply. This is storage space for which contracts have been completed or are being negotiated with States, municipalities, and other local entities. In a few cases it includes water for future use being provided under authority of the Water Supply Act of 1958, for which repayment assurances are required.

In preparing the future flood control program summarized in section VII of this report field offices were requested to consider the need for water supply for municipal and industrial use. As a result it was estimated that about 10.7 million acre-feet of such storage could be provided by works authorized but not started and by the future works considered. Since this appraisal was made prior to enactment of the Water Supply Act of 1958 it is probable that a greater amount of specific municipal and industrial water supply storage could be estimated.

The major difficulty experienced at present, in carrying out the provisions of the act of 1958 is that of defining and securing adequate repayment assurances from non-Federal agencies for water supply storage that will be needed in the future, but which is not needed at present. This is an area where the cooperation of States in providing enabling legislation and in assuming basic responsibility for repayment is badly needed.

Releases to augment low flow.—Perhaps the most important contribution made to the needs of water supply and pollution abatement by reservoirs provided under the flood control program has been the augmentation of low flows by releases of water from conservation storage pools. This beneficial effect has also been obtained by normal releases of water for power development. The relationship between flood control and regulation of low flows is exemplified by the situation in the southwestern part of the United States, including the southern Great Plains area, in 1956 and 1957. In late 1956 and the winter months of 1957 this area was still in the grip of a severe drought which had lasted in varying degrees from 2 to 10 years.

At that time the flood control program was well advanced in that area with reservoirs providing about half the capacity included in the total authorized program. Completed reservoirs provided at that time in the drought area about 20 million acre-feet of total storage (exclusive of Missouri River main stem projects) of which about 13 million acre-feet were reserved for flood control. The remainder included power drawdown storage, reservations for irrigation and water supply, and about 2.8 million acre-feet in permanent conservation pools.

As a result of the long period of below normal rainfall it had not been possible to fill some of these reservoirs, which had been completed during the period. As a general rule it had not been necessary to use flood storage capacity, except in some cases where isolated flash floods occurred. In spite of this circumstance it was possible to make available throughout this area over 3.4 million acre-feet of water annually on the average. In some cases this provided the entire low water flow of streams during critical periods. The storage then available at main stem Missouri River reservoirs contributed during the last 3 years of drought as much as two-thirds of the flow of the Missouri at Omaha for summer and fall periods.

In addition it was possible to make emergency releases in many cases to overcome acute deficiencies in municipal water supply, prevent shutdowns of industry, and to save valuable agricultural crops.

During this period considerable interest was expressed in converting the large flood storage capacity available to water supply storage. In the first place this would have been of little value as there was just not enough rain. Secondly, the Corps of Engineers pointed out that this might be dangerous and should be done only after careful consideration of each case.

The situation changed abruptly after April 1957 when the drought was broken dramatically by long continued rains over Texas, Oklahoma, and parts of adjacent States. Flood storage capacity of the existing reservoirs was completely filled and in some cases recurring floodflows brought emergency spillways into operation. The works prevented damages of over $140 million but damage almost as great was suffered in unprotected areas or in river valleys where flood control plans had not been completed.

At the end of the flood, Corps reservoirs had about 15 million acre-feet of floodwater in storage which had to be released over succeeding months. Conservation and power storages had been replenished and cities and towns dependent upon the reservoirs for water were assured of a supply for some time to come.

Similar but perhaps less dramatic assistance in regulating flows has been afforded in other river basins, such as the Ohio, where substantial storage capacity has been provided.

Total storage capacity.—The total storage capacity made available by reservoirs of the civil works program which are complete or under construction is shown on table 11, broken down by regions. The greater part of this storage is provided by projects carried out as a result of flood control authorization, but that provided by improvements authorized for navigation has been included to give the select committee a summary of the total, as it was believed that this figure would be needed for consideration of overall water storage needs. Similar information is given in table 12 for projects authorized but not started and in table 13 for future projects considered to aid in meeting needs by 1980.

The results of this appraisal may be summarized as follows:

[Millions of acre-feet]

Status	Flood control	Other purposes	Total
Complete or under construction	87.0	126.1	213.1
Authorized, not started	39.5	14.8	54.3
Future work	64.1	88.2	152.3
Total	190.6	229.1	419.7

The flood control storage presented in these tables includes specific reservations for flood storage and the seasonal or joint use storage available for flood control. The designation "other purposes" includes that storage used for river regulation for development of power, augmentation of low flow, and permanent pools below power drawdown for recreational use, preservation of fish and wildlife, and for deposition of sediment over the life of the project. It also includes the specific reservations for municipal and industrial water supply and for irrigation mentioned previously.

TABLE 11.—*Corps of Engineers reservoirs completed or under construction*

[Storage in millions of acre-feet]

Region	Number of reservoirs	Flood control storage	Other purposes	Total storage
New England	27	1.06	0.04	1.10
Middle Atlantic	13	1.76	1.72	3.48
South Atlantic and east gulf	8	7.13	13.99	21.12
Lower Mississippi	7	5.17	2.47	7.64
Southwest and west gulf	19	7.76	5.75	13.51
Arkansas-White-Red	33	19.79	19.97	39.76
Ohio (minus Tennessee)	46	11.20	9.10	20.30
Tennessee				
Upper Mississippi	13	3.27	1.20	4.47
Great Lakes	2	.36		.36
Red River of the North	5	1.04	.19	1.23
Missouri	14	20.64	61.79	82.43
Colorado	5	2.53	.02	2.55
Great Basin				
Central Valley	15	2.72	2.91	5.63
California coastal	12	.42	.07	.49
Columbia	17	1.97	6.90	8.87
North Pacific coastal	2	.21		.21
Alaska				
Hawaii				
Total	238	87.03	126.12	213.15

TABLE 12.—*Corps of Engineers reservoirs authorized but not started*

[Storage in millions of acre-feet]

Region	Number of reservoirs	Flood control storage	Other purposes	Total storage
New England	6	0.13		0.13
Middle Atlantic	11	.97	0.76	1.73
South Atlantic and east gulf	2	.02	.63	.65
Lower Mississippi	2	.29	.52	.81
Southwest and west gulf	7	2.03	1.23	3.26
Arkansas-White-Red	23	11.09	1.98	13.07
Ohio (minus Tennessee)	32	4.64	1.35	5.99
Tennessee				
Upper Mississippi	9	3.70	1.66	5.36
Great Lakes				
Red River of the North				
Missouri	25	8.35	3.07	11.42
Colorado	1	.32	.61	.93
Great Basin	3	.23	.02	.25
Central Valley	3	2.08	.75	2.83
California coastal	1	.08		.08
Columbia	9	5.57	2.17	7.74
North Pacific coastal				
Alaska				
Hawaii				
Total	134	39.50	14.75	54.25

TABLE 13.—*Corps of Engineers reservoirs possible future projects*

[Storage in millions of acre-feet]

Region	Number of reservoirs	Flood control storage	Other purposes	Total storage
New England	25	0.72	0.30	1.02
Middle Atlantic	10	2.33	10.69	13.02
South Atlantic and east gulf	66	4.20	18.36	22.56
Lower Mississippi	2	.48	1.34	1.82
Southwest and west gulf	42	11.64	15.67	27.31
Arkansas-White-Red	72	8.82	16.78	25.60
Ohio (minus Tennessee)	54	5.10	8.73	13.83
Tennessee				
Upper Mississippi	51	5.26	2.18	7.44
Great Lakes	6	.45	.60	1.05
Red River of the North	4	.28	.23	.51
Missouri	20	11.10	10.65	21.75
Colorado	1	.09		.09
Great Basin	4	.38	.01	.39
Central Valley	10	1.03	.41	1.44
California coastal	10	1.19	.52	1.71
Columbia	13	10.23	1.24	11.47
North Pacific coastal	16	.80	.50	1.30
Alaska				
Hawaii				
Total	406	64.10	88.21	152.31

Due to the overlap which results in many cases where the most efficient and economical use of a reservoir involves use of the same storage space for several purposes, it did not appear practicable to make a breakdown of other purpose storage among all project functions.

It seems probable, therefore, that under the future flood control program (sec. VII), a total of 103 million acre-feet of storage can be provided for conservation of water and regulation of riverflows for many purposes.

Pollution abatement.—Releases from reservoirs to augment low water flows of rivers can have a very definite effect in abatement of pollution along downstream reaches of river. In planning for multiple-use projects under the flood control program, however, the Corps of Engineers does not consider that augmentation of low flow should be considered and evaluated as a substitute for control of pollution at the source. In general the future demands for use of water by municipalities and by industry will be so great that the Nation cannot afford to use increased low flows merely to cancel out the reductions in water quality caused by dumping more and more polluting wastes into rivers and streams. In some river basins, however, a proper balance of low flow augmentation and control at the source may be the best solution.

Present indications are that substantial increases in usable water supply can be achieved by reducing pollution at the source and thus improving water quality. The Corps of Engineers and the Public Health Service are now engaged in a joint study of the Arkansas and Red River Basins aimed at reduction of salinity and other forms of pollution which are regional in scope. Similar possibilities of improving water quality exist in other areas, as in the Ohio River Basin where acid mine wastes are a serious problem.

Summary.—The future needs of the United States for municipal and industrial water supply have been forecast in other studies prepared for the select committee. It is obvious that these will be very large and will require a degree of river regulation far beyond anything undertaken in the past. Although reservoirs for flood control and other phases of water resources development have made valuable contributions to water supply, this has been a very small part of the total demand. It seems obvious, therefore, that the more or less incidental attention given to municipal and industrial water supply and to low flow regulation in Federal river basin planning in past years will not suffice to meet the needs which are certain to develop in the future.

In the past major attention has been focused on needs such as navigation, irrigation, flood control, and hydroelectric power, in which some degree of Federal interest has been expressed by law. Water supply for municipal and industrial use, and abatement of pollution at the source, have remained largely the responsibility of private initiative and of local governments. It seems inevitable that this consideration must change, and that water supply must be given major emphasis in future Federal planning for river basin development.

RECREATIONAL USE

Legislative authority.—The possibilities and importance of recreational use of new water areas provided by reservoirs constructed for flood control, navigation, and related purposes was not fully appreciated when the Federal Government embarked on this program. This potentiality was first recognized by the Congress in the Flood Control Act of 1944, which included (in sec. 4) the following language:

> The Chief of Engineers, under the supervision of the Secretary of War, is authorized to construct, maintain, and operate public park and recreational facilities in reservoir areas under the control of the War Department, and to permit the construction, maintenance, and operation of such facilities.
>
> * * * * *
>
> The water areas of all such reservoirs shall be open to public use, without charge, for boating, swimming, bathing, fishing, and other recreational purposes, and ready access to and exit from such water areas along the shores of such reservoirs shall be maintained for general public use when such use is determined by the Secretary of War not to be contrary to the public interest. * * *

The House Committee on Flood Control in reporting out this legislation emphasized that its purpose was to provide—

> authority to expend the small amount of funds needed to make the recreation and conservation values at these reservoirs fully available. * * * This committee is of the opinion that, where practicable, without reducing flood-control benefits, projects should be fully utilized to provide recreational facilities for the benefit of the general public (H. Rept. 1309, 78th Cong., 2d sess., p. 6).

The 1944 legislation was amended in subsequent flood control acts to encourage and facilitate participation of non-Federal agencies in the development of the recreational potential provided by the reservoirs.

DEVELOPMENT OF THE PROGRAM

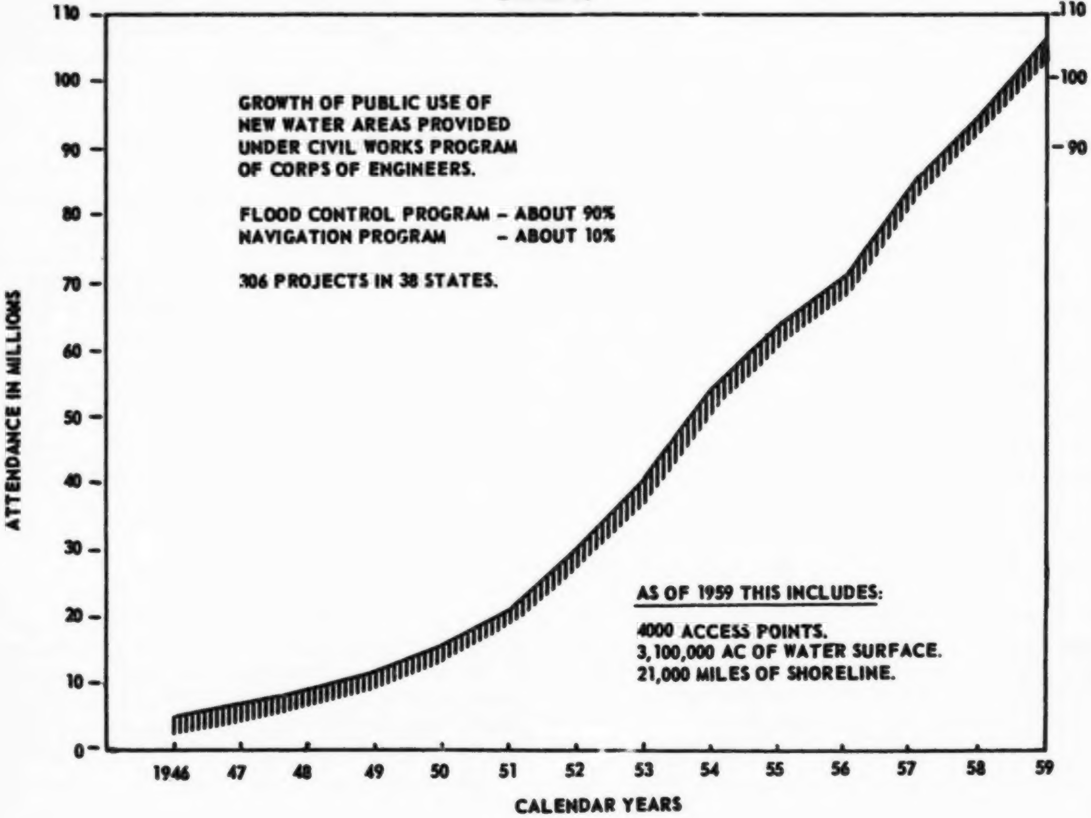
Under the various flood control and river and harbor acts the Corps of Engineers has constructed reservoirs and waterways which have attracted large recreational use. The most important of these are multiple-purpose projects which also provide for generation of power and supply of water for navigation and for municipal, industrial, or agricultural use. As a general rule the pools required for storage of water for these authorized purposes also provide the water areas which afford the recreational resource. In order to make this resource available to and usable by the public, the Corps of Engineers provides the basic facilities for access and public use needed to meet the requirements of the act of 1944 and to encourage further development by non-Federal interests. At over 300 water areas, including some waterways, for which attendance records are maintained by the Corps, there are:

Acres of water surface (summer season)	3, 099, 300
Miles of shoreline (summer season)	21, 389
Points of access	3, 994
Boat-launching ramps	1, 608
Picnic grounds	1, 086
Public campgrounds	630
Organized camps	236
Guest rental units	2, 230

Use of water areas of projects constructed by the Corps of Engineers has increased at a spectacular rate, as shown on figure 10 herewith. In 1946 attendance was about 5 million. In 1959 it was over 106 million. A large part of this 21-fold increase is, of course, attributable to an increase in the number of reservoirs, but recreation at reservoirs constructed prior to 1946 has continued to grow. About 90 percent of this recreational use has occurred at reservoirs of the flood control program, and the remainder at navigation projects.

These projects are located in 38 States and vary considerably in size and type of use. Lake Texoma on the Red River in Texas and Oklahoma draws visitors from long distances and in 1958 showed a record use of over 7 million visitor days. Multiple-purpose reservoirs in the White River in the Ozark region of Arkansas and Missouri have shown increasing recreational use and development. Flood control reservoirs in New England, with small conservation pools, draw smaller at-

FIGURE 10



tendance of a local nature totaling 15,000 to 30,000 visitor days per year. The new water areas provided in the more arid areas of the Great Plains and Southwest, where natural lakes and recreational facilities are scarce or nonexistent, have been particularly valuable.

Records of public use show that a part of attendance at these water areas is general "sightseeing". However, a very large part of the use, about 60 percent on the basis of records at a number of projects, is for the more important recreational activities such as boating, swimming, camping, fishing, and picnicking. These records also show that, while the most intensive use generally occurs during summer months, there is a substantial and increasing year-around use of the water areas.

In providing these new water areas and lands required in connection with them the corps has provided valuable means for the preservation and enhancement of the fish and wildlife resource, which is closely related to the recreational feature. In 1958 over 21 million pounds of sport fish were taken from these new water areas.

The Corps of Engineers has spent about $11 million through fiscal year 1957 in providing the minimum basic facilities necessary for access and public use at these projects. This amounts to less than one-half of 1 percent of the total project cost. The greater part of this Federal cost (well over 60 percent) has been for access facilities such as roads, parking areas, and boat launching ramps. The roads and access facilities so provided are over and above these required for project operation for other purposes such as flood control. Access roads necessary for project operation, however, often serve a dual purpose in permitting access for recreational use. During the same period non-Federal entities, on the basis of incomplete estimates, have spent about $140 million in further development of the recreational resource.

Leasing and concessions.—Project areas suitable and available for leasing to non-Federal agencies or development by concessionaires are established in a master plan for reservoir development and management. This master plan is prepared by the responsible district engineer in cooperation with other interested Federal agencies and with State and local agencies concerned.

In some cases the areas, so established are made available by lease to States, counties, cities, and other local governmental agencies for development and operation in accordance with the master plan. Such non-Federal agencies may in turn grant concessions in conformity with standards and requirements set by the Federal plan. In other cases, when local sponsorship is not readily available, as in isolated regions, areas are leased by the Corps of Engineers directly to concessionaires. The type of development usually granted to concessionaires includes boat docks and rentals; care of privately owned boats, sale of fuel, provisions, sporting supplies and equipment, restaurants, beach auxiliary structures, and the care and maintenance of the areas concerned.

While lessees or concessionaires may charge fees for services rendered or supplies provided, care is exercised to insure that such fees are not made a requirement for access and use of the water areas, which under the act of 1944 are to be open to public use without charge.

Figures available in the Office, Chief of Engineers, indicate that about $15 million in revenue has been received from leases, including leases of land for agricultural purposes, and from concessions. For fiscal year 1959 the total received amounted to just over $1,900,000. In 1953 these revenues amounted to about $1,300,000. Section 4 of the act of 1944 provided that money so received would be returned to the U.S. Treasury as miscellaneous receipts. Subsequent legislation, however (sec. 5 of the Flood Control Act of 1946, as amended) provided that 75 percent of all money received for leasing land acquired by the United States for flood control should be returned to the States in which such property is located for use by counties concerned for schools, roads and other public purposes. Accordingly, money received from leases and concessions is so returned to the States. The only exception is money received from a concession for personal service, such as guide service, which does not involve land. Such returns which are very small go to miscellaneous receipts of the Treasury.

It should be noted that the returns described above are from leases and concessions to non-governmental agencies. By far the greater part of the use of project areas thru leasing arrangements is by States, and other non-Federal governmental agencies to which leases are granted without monetary consideration under the act of 1944.

Operation for recreational use.—The reservoirs of the civil works program are operated by the Corps of Engineers for recreation and other public uses in consonance with other project purposes specifically authorized by Congress. In appropriate cases the development of the recreational facilities is turned over to the Forest Service where projects involve national forest lands, so as to avoid duplication of agency responsibility. The Corps of Engineers considers in general, however, that the agency responsible under congressional authority for construction and operation of water resources projects should administer the recreational resources created by them. Project purposes such as flood control, navigation, water supply and irrigation should not be subordinated to recreation in project operation. Divided responsibilities for project operations would create undesirable conflicts and might interfere with purposes for which projects were originally authorized.

Future consideration.—The matter of recreational use of water areas provided by works of the flood control program, and related water resources programs, has been presented in some detail because of its growing importance as a water use. The public demand for this type of outdoor recreation and pressure for consideration of recreation as a purpose of Federal projects for flood control and other purposes will undoubtedly increase over the next two decades. This points to the need for legislative clarification of the role of the Federal Government in planning and providing this resource.

No attempt has been made to forecast the recreational use which might develop on the new water areas that would develop under a future program for river regulation. Extension of growth in recreational use during recent years would approach astronomical proportions by 1980. Experience in planning for water resources in certain major river basins, however, indicates an almost unlimited demand for the type of outdoor recreation which water resources projects can provide.

FISH AND WILDLIFE CONSERVATION

Authority.—In accordance with the Fish and Wildlife Coordination Act of 1958 (Public Law 85–624) the conservation of fish and wildlife resources constitutes a purpose of water resources development and is given full consideration in the planning of Federal multiple-purpose projects for navigation and flood control and for related multiple-purpose developments. The 1958 law is a positive authority for consideration of the fish and wildlife resources in river basin development, and a legislative recognition of the fact that such development can enhance the resources. Prior legislation was negative as it laid emphasis on prevention of damage.

Under the 1958 Coordination Act the Corps of Engineers is authorized to include provisions for preservation and enhancement of fish and wildlife in flood control and other projects recommended to Congress for authorization. Authority is also given to modify authorized projects not more than 60 percent complete to provide for fish and wildlife, and to acquire lands for this purpose when such acquisition is specifically authorized by Congress on the basis of a recommendation by the Chief of Engineers. Such modifications and recommendations for land acquisition would, of course, be based upon justification and recommendation of the Secretary of the Interior and upon concurrence of the State authorities concerned.

Under the authority of the 1958 act project costs may be allocated to fish and wildlife as a project purpose, just as they are to other authorized project purposes. The 1958 act is not specific as to sharing of costs so allocated and leaves this for determination by the Secretary of the Interior and by the agency reporting to Congress.

Most of the need for coordination with fish and wildlife requirements has arisen since initiation of the general flood control program as a result of the Flood Control Act of 1936. Navigation projects, however, also present similar problems and potentialities, and are closely related in their effect upon fish and game resources. Consequently, in this section of the report the effect of all water resources projects of the Corps of Engineers is considered.

Consideration in program.—Over the years, water control projects of the Corps of Engineers have made outstanding contributions to fish and wildlife conservation of widespread national and international significance. Reservoirs constructed by the Corps have provided more than 3 million surface acres of new fishing waters and habitat for migratory waterfowl and an equal amount of upland range made available for the first time for wildlife purposes in 35 States.

Located in the heart of the major river systems of the country, and in many instances on the continental flyways for migratory waterfowl, many of these reservoirs constitute important new segments of the Federal system of wildlife refuges. They also facilitate development by State and local agencies of a balanced system of public shooting areas. Outstanding among these areas are the Fort Peck Reservoir project which provides the largest part of the Fort Peck Big Game Range, the Great Salt Plains Reservoir and National Wildlife Refuge, the upper Mississippi River navigation project which extends the influence of the Upper Mississippi River Migratory Waterfowl Refuge throughout the upper Mississippi in the five bordering States between Minneapolis and St. Louis, and the national wildlife refuge currently being established at the Jackson lock and dam project on the Tombigbee River in Alabama. The last-mentioned reservoir is a significant unit in a chain of reservoirs in the Ohio, Cumberland, Tennessee, Warrior, Black Warrior, and Tombigbee Rivers that has created a new reservoir flyway for migratory waterfowl linking the Ohio River Basin with the gulf coast waterfowl wintering grounds.

A total of 104 licenses have been issued by the Department of the Army at 150 of its reservoir projects in 29 States for use of 1,079,000 acres of these lands and waters by the Federal and State fish and wildlife agencies without charge in carrying out their respective programs for fish and wildlife management. These areas provide essential lands and waters for refuges for protection of all forms of wildlife, management areas for production of food and cover, resting grounds for migratory species, experimental areas, headquarters for administrative sites, demonstration areas, public shooting grounds and other conservation activities.

Substantial new trout fisheries have been established in the cold water released by several of the large dams constructed and operated by the Corps in suitable locations, notably in the Ozarks region. These are sustained and developed by large fish hatcheries constructed and operated by the State and Federal fishery agencies.

Progress has been made in modification of project plans to provide features for prevention of loss or damage to fish and wildlife resources which otherwise might result from construction of water resource improvements for other purposes. These improvements include restoration of habitat lost by impoundment, regulation of downstream flow in the interest of fish and wildlife resources, provisions for pollution abatement, fish passing facilities at dams for both upstream and downstream migrants, sport and commercial fish hatcheries for sustaining runs of fish blocked by high dams, fish trapping and transporting facilities, and artificial spawning grounds

Progress is also being made in reducing some inherent conflicts between engineering works for control and development of water resources and the value of natural areas as habitat for fish and game. For example, agreement has been reached between the Corps of Engineers and Fish and Wildlife Service which will enable the Corps to consider advice of the Service and of State fish and game agencies in selecting areas for disposal of spoil from dredging of channels. Continuation of this cooperative effort should aid in reducing adverse effects upon marshy areas.

The preservation of the salmon runs of the Columbia River Basin at a consistently high level over the more than 20 years since the first multiple purpose dam was placed in operation on the main river is a singular accomplishment of engineering and biological endeavor. These endeavors include a program for preservation and development of the fishery potential of the river system incident to construction of many dams in the basin. These improvements planned and carried out at a cost of $28 million include removal of natural and man made blockage of streams, provision of fishways at some dams, bypass facilities at natural falls, improvement of spawning grounds, screening of agricultural and industrial water diversions, construction and operation of fish hatcheries, and fish trapping and transportation facilities, combined with regulation of fish harvest and other administrative controls over utilization of fishery resources. The overall cost of fish facilities provided at Corps of Engineers dams in the Columbia Basin and in these auxiliary programs in connection with dam construction as now planned will be approximately $175 million.

Problems.—In the conduct of essential river basin developments for flood control, navigation, water supply, and other purposes it is inevitable that problems and conflicts of interest will arise, and that some values will be lost. The Corps of Engineers recognizes the importance of these matters and believes that they must be resolved in the overall public interest.

There is at present no generally accepted basis for evaluating the benefits from preservation and enhancement of the fish and wildlife resource. It is recognized that it may not be possible to evaluate in monetary terms the scientific and conservational aspects of preservation of species, but other aspects of this resource such as the recreational values of sport fishing and hunting, and the commercial fishery values would seem to be possible of economic evaluation. When substantial sums of Federal money are required for project modifications some sound method of economic justification is indicated. Furthermore, the allocation of project costs to fish and wildlife requires that it be evaluated on a basis as nearly as possible like other project purposes.

Greater public understanding of the relationship of works for flood control and other river basin development to fisheries and wildlife is of major importance. The real facts about this relationship are often ignored and reasonable solutions are made difficult when the approach is emotional, rather than practical and factual. There is a real need for public understanding of this problem.

There are certain rivers and streams of the country which should, because of their natural beauty, historic interest, or peculiar conservational values, be preserved in their natural state for recreational use and for preservation of fish and wildlife, if this is compatible with the Nation's need for water and water control. The Corps of Engineers has recognized in the past the desirability of retaining such natural values. For example, it has dropped consideration of dams on the Current River of Arkansas and Missouri and in certain headwater areas of the James River Basin in Virginia for these reasons. In preparing plans for the Columbia River Basin the Corps of Engineers is not recommending at this time the Nez Perce Dam, although it would have great value for power development, because it would block access to the Salmon River of Idaho. Cases of this kind must be decided upon individual merit giving full consideration to all factors, economic and intangible.

The creation of substantial new fish and wildlife resources also creates new problems in development of water control projects and management of resources so as to realize the greatest practicable benefits. Much information not now available is needed for understanding of reservoir fisheries, how they develop over the years, what factors govern their welfare, and how they may be utilized to best advantage. Research is also needed on the effects of controlled discharges of water at dams upon water quality downstream and its relationship to the downstream fishery. Information is also needed as to the effect of discharges and withdrawal of water from various levels in the reservoir upon the fishery in the reservoir and the relative merits of these upstream and downstream effects. In brief, if fishery and wildlife values are to achieve proper stature as a real purpose of Federal river development projects, there is need for much basic research in fishery biology and in the planning and management of water areas.

Future possibilities.—It has been pointed out elsewhere in this study that future demands upon the water resource will require a degree of river regulation far beyond anything previously contemplated. Such a degree of river regulation will inevitably result in the loss of some natural habitat for fish and game, but it will also result in creation of large new water areas and in cleaner rivers and streams.

Existing civil works projects now provide over 3 million acres of new water areas. Projects of the future flood control program, including those authorized but not started, as envisioned in this report would about double present storage capacity. Future programs for navigation and for reclamation would increase this total. Since most of this storage will be multiple purpose in nature involving permanent pools, it is not difficult to visualize additional new water areas of 10 million acres or more for the foreseeable future.

If fish and wildlife resources are given proper consideration in the planning and construction of these future engineering works there is every reason to believe that major fish and wildlife values can be preserved and enhanced for future generations. The benefits derived from fish and wildlife features of water resource development projects of the Corps of Engineers are reflected primarily in the recreational use of water resources. As the population of the country develops and depends to a greater extent upon these resources for its economic welfare, the potential of reservoir fisheries for production of commercial food supply will also reflect substantial benefits in the surrounding areas and regions in which they are located.

SECTION X—SLOWING DOWN THE CREATION OF NEW FLOOD PROBLEMS

In the general discussion of measures for reducing flood damages it was pointed out that one major approach is to accommodate the use of the flood plain to the flood risk. This can be accomplished by either (1) abandonment of the flood plain or (2) the regulation of flood plain use. Abandonment is, of course, a temporary solution; for eventually the flood plains of the Nation will have to be put to their optimum use. In the long run, therefore, flood-plain regulation is the only acceptable means of reducing future flood damages by the adjustment of use to risks. Flood-plain regulation reduces future flood damage by preventing the development of new flood problems, or by slowing down the rate at which new problems are created.

FLOOD-PLAIN REGULATION

Flood-plain regulation can take many forms. It can be as rigorous as excluding all building from high risk areas by the zoning of those areas for uses which will not create flood problems—such as parks and athletic fields, or it can take the form of local building codes requiring that buildings constructed in areas subject to flooding shall be so designed that they will not suffer excessive damage during floods; an approach often referred to as "flood-proofing." The wide range of possibilities, as well as experience in flood-plain regulation throughout the Nation, has been recently reviewed in the publication "Regulating Flood-plain Development," Department of Geography Research Paper No. 56, the University of Chicago Press, November 1958.[14] The principal techniques for reducing flood damages by regulation of flood plain use are listed in that paper as:

1. Establishment of encroachment lines.
2. Use of zoning ordinances.
3. Revision of building codes.
4. Carrying out of urban renewal projects.
5. Use of flood insurance as an incentive to proper flood-plain use.

Whatever form flood-plain regulation may take, it can be of great value to the Nation by reducing the rate of growth of flood damages in the future. The analysis upon which figure 7 was based indicates that the average annual expenditure for flood control projects during the next 20 years at the present rate will do little more than hold the flood damage potential at its present level. It has been estimated that the total flood damage potential will increase by over $300 million annually by 1980 if nothing further is done. Avoidance of an annual loss of this magnitude would have a capitalized value of about $12 billion. This figure is given only to show how important it is, from the standpoint of the national economy, to do everything possible too slow down the creation of new flood problems by flood-plain regulations. The foregoing discussion is not intended to imply that there should be a complete cessation of building within the flood plain or that such a condition is likely of attainment. In some instances it may be more economic to the Nation to develop the flood plains to higher use and provide protection through construction of additional flood-control works than it would be to restrict their use. The objective is to regulate the use of flood-plain lands to provide for their optimum economic use, not to preclude their use.

The Tennessee Valley Authority extends technical assistance to city governments and other local governmental entities [15], in developing flood-plain regulations. This program has demonstrated that when communities are able to obtain information and expert assistance from the Federal agencies, they are much more likely to utilize their flood-plain lands intelligently. This is in line with Murphy's conclusion, based upon his nationwide survey, that the Federal agencies having flood information should make it available to State and local governments as a basis for flood-plain regulation, and should also extend advice and assistance in this field. It is obvious that the cost to the Federal Government of any such service would be far less than the cost of achieving an equivalent reduction in future damages by the construction of engineering works.

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[14] This report was prepared by the late Francis C. Murphy while on leave from his regular post in the office of the district engineer, Corps of Engineers at Seattle, Wash. Mr. Murphy's study was made possible by a research and study fellowship grant from the Secretary of the Army.

[15] "A Program for Reducing the National Flood Damage Potential," committee print, 86th Cong., 1st sess., 1959. Also see "Flood Problems and Management in the Tennessee River Basin," Committee Print No. 16, Select Committee on National Water Resources, 86th Cong., 1st sess., December 1959.

In addition the River and Harbor and Flood Control Act of 1960 (Public Law 86–645) approved July 14, 1960, authorizes the Corps of Engineers on a nationwide basis to provide States an municipalities with flood-plain information to assist them in planning for regulation and use of flood plains.

The previous section of this report shows that even if the fullest possible use is made of flood-plain regulation there will still be a major need for flood-control projects. The big difference would be that if the creation of new flood problems could be substantially slowed down, the effect of future flood-control projects would be to reduce the present drain upon the Nation's economy, rather than merely canceling out the additional losses attributable to more intensive, and often unwise, use of flood-plain lands. If the Nation continues to limit itself to the construction of reservoirs, levees, and similar works as a remedy for its flood problems, flood losses in the future will continue to be a serious drain on the national economy.

SECTION XI—OTHER FLOOD CONTROL ACTIVITIES OF THE FEDERAL GOVERNMENT

In addition to the responsibilities it has assumed under the Flood Control Acts, the Federal Government contributes to flood control through the construction of small engineering works under the authorities of the Watershed Protection and Flood Prevention Acts (Public Law 566 and legislation supplementing and amending that act), and by providing flood control capacity in some reservoirs constructed under the Federal Reclamation Acts.

THE WATERSHED PROTECTION AND FLOOD PREVENTION PROGRAM

Under Public Law 566, as amended, the Soil Conservation Service of the Department of Agriculture prepares watershed work plans at the request of various types of watershed organizations; usually soil conservation districts. These plans provide for the construction of systems of small reservoirs, levees, channel improvements, and other engineering works to reduce flood damages along creeks and other minor headwater streams. After a work plan is accepted by the local organization, and approved by the Administrator of Soil Conservation Service, the latter agency prepares the detailed plans and specifications for the dams and other works. The local organization then enters into contracts for the construction of the works. Construction is normally supervised by the Soil Conservation Service. That agency also provides Federal funds for the payment of all construction costs. The local organization furnishes lands, easements, and rights-of-way, and agrees to maintain the works after they are constructed.

Work plans for Public Law 566 projects also indicate the land-treatment measures that should be established on the lands of the watershed to conserve and improve the soil. Normally these measures do not constitute a part of the Public Law 566 project; they are installed, rather, under the regular agricultural programs of the Federal Government and the State. In some instances, as when gully erosion above a proposed reservoir would cause it to fill quickly, special land-treatment measures are carried out as part of the Public Law 566 project and financed in part with funds appropriated under that act.

Public Law 566 also authorizes the construction of multiple-purpose engineering projects. The purposes, other than flood-damage reduction, which such projects may serve include reclamation by drainage or irrigation, the provision of municipal and industrial water supply, fish and wildlife enhancement and provision of recreational opportunities. The cost-sharing provisions for the various purposes differ. It is only for the purpose of "flood prevention" that the Federal Government bears the entire cost of construction.

The engineering construction program being carried out under the authorities of Public Law 566 is subject to certain limitations. The chief of these is that no more than 5,000 acre-feet of reservoir capacity may be provided for flood control in any single reservoir. Another limitation is that plans must be limited to drainage areas of less than 250,000 acres (390 square miles), except under special conditions. While many Public Law 566 projects are for the protection of urban areas against floods, these are usually limited to systems of reservoirs, the Soil Conservation Service and the Corps of Engineers having entered into an agreement that the latter agency will normally undertake projects for the protection of urban areas by levees, channel improvements, and other local protection works.

Before Public Law 566 was enacted the Soil Conservation Service undertook "watershed" projects, similar in nature to Public Law 566 projects, under authorities provided by the Flood Control Acts, as well as under the authority of the Soil Conservation Acts. The overall "watershed" program now underway is, therefore, based upon three bodies of legislation. It is presumed, however, that all future projects will be undertaken pursuant to Public Law 566 authorities.

According to a recent report to the Select Committee on National Water Resources,[16] 1,802 reservoirs had been constructed, or were being constructed, in 1959 under the watershed program. This report also predicts that there will be 17,300 such reservoirs by 1980, and 35,700 by the year 2000. Grade stabilization structures, debris basins, levees, channel improvements, and other engineering works for the reduction of flood damages are also constructed under this program.

FEDERAL ACTIVITIES UNDER THE RECLAMATION ACTS

The Reclamation Project Act of 1939 authorized the inclusion of capacity in Bureau of Reclamation reservoirs for the control of floods. Under this act all costs allocable to that purpose are borne by the Federal Government.

In a report submitted to the Select Committee on National Water Resources by the Secretary of the Interior on April 20, 1960,[17] indicates that as of 1958 more than 38 million acre-feet of reservoir storage in projects wholly or in part for irrigation was useful for flood control, part of which was joint use storage which would be available for flood control on a seasonal basis. Inasmuch as the Department of the Interior report apparently included reservoirs with irrigation storage which have been constructed or will be constructed by the Corps of Engineers, the above cited figure on control storage would to some extent duplicate that presented by the Corps of Engineers. If limited to joint-use storage in projects of the Department of Interior about 23 million acre-feet would be available for flood-control use. In this same report it is indicated that future projects associated with irrigation would provide 22 million acre-feet of similar storage useful for flood control.

THE TENNESSEE VALLEY AUTHORITY PROGRAM

One of the major objectives of the TVA Act of May 18, 1933, was the construction of dams and reservoirs in the Tennessee River Basin to control destructive floodwaters in the Tennessee and Mississippi River drainage basins. In furtherance of that and other objectives of the act, the Authority now operates a system of 25 major dam and reservoir projects, including 9 on the main stem of the Tennessee River and 16 on its tributaries. Storage reservations for flood control are provided in 8 of the main stem and 10 of the tributary projects.

The reservoir system is so operated as to provide a dependable storage capacity for flood control of at least 11,800,000 acre-feet on January 1 of each year.[18] This capacity may be reduced as the season advances to 10,400,000 acre-feet by mid-March and to a minimum of about 2,500,000 acre-feet during the summer months. Flood control operation of projects other than Kentucky

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[16] Committee Print No. 13, Select Committee on National Water Resources U.S. Senate, "Estimated Water Requirements for Agricultural Purposes and Their Effects on Water Supplies."

[17] Committee Print No. 14, Select Committee on National Water Resources U.S. Senate, "Future Needs for Reclamation in the Western States."

[18] Committee Print No. 16, Select Committee on National Water Resources, U.S. Senate, "Flood Problems and Management in the Tennessee River Basin."

Dam and Reservoir, near the mouth of the Tennessee River, is in the interest of flood control within the Tennessee Basin. Flood control operation of the Kentucky project is carried out, in coordination with the Corps of Engineers, with the objective of minimizing flood crests on the lower Ohio and Mississippi Rivers in conjunction with the effect of reservoirs provided by the Corps of Engineers in the Ohio Basin and in other river basins tributary to the lower Mississippi.

OTHER FEDERAL FLOOD CONTROL ACTIVITIES

Flood control is one of the purposes of the reservoir system constructed by the International Boundary and Water Commission within the basin of the Rio Grande. As of 1955 the total cost allocated to flood control by this agency was about $58 million.[19]

As indicated previously forest protection, soil conservation and other land treatment measures installed under the regular program of the Department of Agriculture also serve to reduce flood runoff. However, the effect of such measures upon major floods has been found to be small. In general, therefore, the flood control effects of land treatment programs are considered incidental to their primary purpose of conserving and improving the soil, and of increasing the efficiency of the Nation's agriculture.

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[19] "Report of Task Force on Water Resources and Power," Commission on Organization of the Executive Branch of the Government, Vol. 2, June 1955, p. 786.

SECTION XII—APPRAISAL OF FEDERAL FLOOD-CONTROL ACTIVITIES

In this section is presented the results of an attempt to appraise briefly the Federal flood-control efforts reviewed in the previous sections. The appraisal covers both accomplishments and weaknesses. But in view of the mission of the select committee—which is to seek out ways of improving present programs—emphasis has been placed on the steps which might be taken to strengthen existing policies and procedures.

ACCOMPLISHMENTS TO DATE

The Federal program being carried out under the Flood Control Acts may be credited with accomplishments unparalleled by those of any public works program ever undertaken by any nation. In brief, this program has resulted in—

1. The virtual elimination of the possibility of major flood disasters at those cities where, before the Federal Government assumed responsibility, tragic losses of life and spectacular destruction of property had so often appalled the Nation.

2. A large reduction in average annual flood losses, which represent a large and steady drain upon the Nation's wealth.

3. The gradual evolution of the concept of comprehensive and coordinated programs for the development, utilization, and conservation of the resources of the Nation's major river basins. In this respect the program carried out under the Flood Control Acts has constituted the bridge between the wasteful past, and an age in which the Nation's standing as a world power will depend upon the efficient use of its natural resources.

Elimination of potential disasters.—As pointed out in section III, the Federal Government originally accepted only limited responsibilities in the flood-control field. When the 1936 act was being formulated it was repeatedly stated in the Congress that the Federal Government would confine itself to projects for stopping the losses of life and property which resulted from the inundation of cities by floods so great, and so rare, as to be considered "acts of God." The fact that the Federal program was soon broadened to provide for the protection of agricultural areas in both large and small valleys, did not divert the Congress from giving first priority to projects to protect urban areas where the risk of loss of life was high.

As a result, the Corps of Engineers, pursuant to congressional directives, for many years after 1936 concentrated upon the solution of major flood problems. This concentration has led to the elimination of nearly all of the worst "death traps" which existed before 1936. It is no accident that table 1 shows for the past 20 years a remarkable decrease in the frequency of occurrence of flood disasters in which more than 100 lives are lost. There are, of course, still situations in which loss of life may be heavy. This was demonstrated by the abnormal 1955 hurricane floods in New England. But the Flood Control Act of 1936, and subsequent amendments thereto, have obviously accomplished the main objective the Congress had in mind when it finally decided, after many years of controversy, that "destructive floods * * * constitute a menace to national welfare," and hence "that flood control * * * is a proper activity of the Federal Government".[20]

Reduction in flood losses.—The program carried out by the Corps of Engineers under the Flood Control Acts has been successful in greatly reducing flood damages in the United States. As indicated in section VIII of this report the projects complete or in operation have prevented large flood losses over the years since the program began to be effective. The current estimate of $9 billion of gross damage prevention to date is an indication of the value of the program in reducing flood losses plus its effectiveness in bringing about very intensive industrial development of the flood plains of major rivers.

Evolution of a new concept.—In the long run it will probably be found that the most important contribution of the Flood Control Acts to the Nation's welfare has been the key role they have played in the development of the modern concept of comprehensive and coordinated river basin development. Such concepts develop slowly, and achieve general acceptance even more slowly. There can be no doubt that had it not been for the experience gained by the Nation through its flood-control program, there would not be today such widespread acceptance of the idea that the resources of major regions should be developed under broad and unified plans. Looking back, this development seems to have been a very natural one. But it took actual experience in the public-works field to gain wide acceptance for the idea that if the Federal Government was to build reservoirs for holding back flood waters it should make them of greater value by using them to develop power, to store water for municipal and industrial use, to provide recreational opportunities for the people, and to achieve the other objectives which are now almost universally accepted as the proper goals of river development. Thus gradually, and sometimes only after much controversy, did the concept of optimum development of the Nation's rivers gain the wide acceptance it enjoys today.

All of the foregoing are notable accomplishments. They were possible in large part because there has been a willingness on the part of the Congress to broaden the Flood Control Acts whenever it became convinced that the changing circumstances and emerging needs justified a change in the Federal program. This evolutionary phase is still underway, and opportunities for still further improvement of the program constantly present themselves. The remainder of this section will be devoted to the discussion of a number of the improvements which experience has demonstrated merit consideration at the present time.

FUTURE ACCOMPLISHMENTS

The future accomplishments in reduction of flood damage that may be anticipated from continuation of the Federal flood-control program program are described in section VIII of this report, and are summarized below.

(*a*) Completion of authorized flood-control programs and provisions of the additional engineering works that appear feasible could result in greatly reducing the 1980 flood damage potential in spite of continued development of flood plains.

(*b*) Continuation of the flood-control program, however, at the current rate of Federal expenditures will enable flood protection to just about keep up with the increase in flood damage that may be anticipated as a result of intensive use and development of flood plains over the next two decades.

(*c*) Federal expenditures on the basis of flood-control appropriations increasing to $500 million by 1970 and continuing at that rate could reverse the trend of increasing flood damage.

IMPROVEMENT OF THE FEDERAL FLOOD CONTROL PROGRAM

The experiences of the past indicate that Federal activities under the various legislative authorizations reviewed in section III could be made more effective by—

1. Expanding the present programs to encompass provisions designed to (*a*) encourage regulation of the use of flood plains and (*b*) preserve important reservoir sites for future use.
2. Providing for more effective coordination all activities affecting the development, use, and conservation of the resources of major river basins.

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[20] Quotations from sec. 1 of the Flood Control Act of 1936.

3. Eliminating differences in basic policies, and particularly, those policies having to do with (*a*) the division of cost between the Federal Government and non-Federal entities, and (*b*) the procedures for authorization of Federal projects.

4. Amending the basic legislation to more fully reflect the modern concept of comprehensive and coordinated programs for the major river basins, or other regions, of the Nation; taking into consideration that at present the modifications most urgently needed are those which will make it possible to plan basinwide reservoir systems capable of regulating the major rivers for all purposes.

Needed expansions.—As indicated by 1 above there is a need for an expansion of existing programs and authorities with a view to encouraging proper regulation of flood-plain use, and to preserving important reservoir sites until they are needed.

The importance of the regulation of flood-plain use has already been brought out in section VIII and X of this report. It was shown therein that even if engineering works for flood-damage reduction are constructed at an unprecedented rate over the next 20 years the Nation will, at the end of that period, still be suffering the destruction of its wealth at a rat averaging at least a half billion dollars a year, unless something is done to slow down the creation of new flood problems. Thus the States and their subdivisions have it within their power to make a substantial contribution to flood control which could ultimately relieve the Federal Treasury of at least a part of the burden of protection against future flood problems. This is a way in which States and local governments can make a contribution to solution of the future flood problem which would in some cases be equivalent to action by the Federal Government.

The Federal Government can do much to encourage proper use of flood plains. Federal agencies, such as the U.S. Geological Survey and the Corps of Engineers, have a great store of information on flood magnitudes and frequencies. The Corps of Engineers also has a decentralized technical organization capable of providing flood-plain maps, showing the areas subject to flooding by floods of various magnitudes and frequencies. Hence one very important contribution the Federal Government can make to more intelligent use of flood plains is to provide the information which the States and their subdivisions need to enable them to put into effect zoning or other regulations. Legislation which would authorize the Corps of Engineers to provide such a service has already been provided in section 206 of Public Law 86–645 approved July 14, 1960.

In the ultimate analysis the success or failure of flood-plain regulation is up to the States; for it is in the States that the police power resides. It is encouraging to note, therefore, that the Council of State Governments is taking steps to encourage the enactment of State legislation that will make flood regulation more effective in the future.

There is also an urgent need for measures to preserve important reservoir sites. The development of flood-plain areas is now so rapid that the future development of some of the best sites for major storage reservoirs is being rendered uneconomic. A program to preserve these sites would fit in very well with the flood plain regulation program previously discussed. States could be encouraged to reserve certain areas for future storage reservoirs, and in certain instances to acquire such sites for use as public recreational areas. A Federal contribution toward the acquisition cost would not only encourage the State recreational programs, but also insure that the sites would be available for Federal use when needed. In some instances it might be found wise for the Federal Government itself to acquire especially important sites, possibly leasing them to the States and other public entities for recreational, or other use, until needed. The first step, however, could be limited to congressional authorization of a study of future needs for major reservoirs, and the submission of a report recommending the specific steps that should be taken to preserve the more important sites.

The need for improved coordination.—Those reservoirs paid for in whole or in part by the Federal Government should constitute elements of the "best" reservoir system for the river basin in which they are built. And, in planning such a system, consideration should be given to all of the purposes which reservoirs can serve in the development of the basin. If this line of thinking is carried to its logical conclusion it becomes evident that nearly all water resource development projects within a river basin are, to a greater or lesser extent, interrelated and interdependent. But of greatest practical importance at this time is the coordination of plans for reservoirs.

The obvious way to achieve such coordination is to require that all developments within a basin shall fit as nearly as possible into and constitute an integral part of a comprehensive plan for the optimum development of the basins resources. This concept is now well established and the Congress has taken a number of steps to implement it. One important step in this direction is the efforts the Congress has recently undertaken to bring about the formulation of comprehensive plans for major river basins, or groups of basins. To this end Congress has, in a number of instances, authorized the Federal agencies to develop overall plans for important regions. At the present time comprehensive plans have been completed or are being completed under the leadership of the Corps of Engineers, and in full cooperation with States and other Federal agencies, in the Delaware and Columbia River Basins, and are being developed for the river basins of the Southeast, and for the Texas basins, by "Study Commissions" established by Congress for the purpose. Such developments indicate that the Congress is willing to do its part to implement the concept of comprehensive and coordinated developmental plans. However, there are other steps which need to be taken to insure full coordination.

The need for uniform policies.—There still exist important differences in the legislative policies underlying the various programs by which the Nation is striving to make the most of its resources. Of particular importance from the standpoint of flood control are (*a*) differences in cost-sharing policy and (*b*) differences in the policies controlling the manner in which projects come into being.

The need for a more equitable policy for dividing the cost of local protection projects between the Federal Government and non-Federal interests has already been discussed previously in this report. The Chief of Engineers has proposed legislation aimed at securing uniformity in cost sharing for local flood-control projects. This proposal was expanded in the bill introduced as S. 2060 in the 86th Congress to extend such cost sharing to major reservoirs. This revives a difficult problem confronted by Congress in 1938 and resolved in the Flood Control Act of that year. But this bill deals only with flood control. There are also basic differences between cost-sharing policies for flood control and reclamation that should ultimately be eliminated. Flood-control projects also lead to the "reclamation" of land in the sense that they sometimes make possible more intensive, and thus more profitable, use of flood-plain areas. The more intensive use is sometimes made possible by improved drainage, sometimes by a reduction in the flood hazard, and sometimes by a combination of the two. At the present time no distinction is made, by the Department of the Army, between changed land use made possible by improved drainage and changed use made possible by reduction of the flood hazard, as this Department complies with Bureau of the Budget Circular A-47 which requires all "enhancement" benefits to be treated the same for cost-sharing purposes.

However, for similar projects constructed under Public Law 566 local interests are not required to bear one-half the first cost allocable to the "enhancement" component of a project when the enhancement (i.e. changed use) is made possible by a reduction in the flood hazard. Moreover, when the change in use is made possible by improved drainage the Department of Agriculture arrives at the non-Federal share of the cost by a method somewhat different from that prescribed by Circular A-47; whereas the Department of the Army complies with that circular by recommending that local interests assume one-half the first cost. Finally the share of the cost borne by the Federal Government under the Reclamation Acts is controlled by a fundamentally different policy under which the share of the cost to be borne by the beneficiaries may vary, not only with the benefits they derive from the project, but also with their "ability to pay," as well as by the amount of power that can be generated at dams which have been, or may be, constructed in the river basin.

Obviously what is needed is a policy under which all who benefit as a result of changes in land use (that is, who receive "enhancement" or "reclamation" benefits) are equitably treated by the Federal Government. As the resource development activities of the Nation become more fully integrated under comprehensive plans such as those now being actively sought by the Congress, the differences between cost-sharing policies will become increasingly obvious and increasingly troublesome.

In fact they are already so obvious that immediate steps should be taken to develop a uniform national policy on cost sharing for the reclamation components of all Federal resource development activities.

There is also a real need for eliminating differences between the policies governing the manner in which projects are authorized. All important projects undertaken pursuant to the Flood Control Acts must be individually authorized by an act of Congress. Subsequently appropriations are made such project. As a result of this procedure several years usually elapse between the time a Flood Control Act project is planned and the initation of construction. In contrast, projects constructed under the authorities of Public Law 566 can be placed under construction within a few months of the time very general "work plans" are developed. This, of course, makes it extremely difficult to coordinate the planning and construction of interdependent works, some of which are to be constructed by the Corps of Engineers and some by the Soil Conservation Service under Public Law 566. For example, the Corps of Engineers recently developed a plan for the improvement of a main stream into which discharge a number of smaller drainage channels to be under Public Law 566. In such a case the Public Law 566 project can be initated within a few months. But it may be 5, or even 10, years before the Corps project can be carried out.

Bringing existing laws into harmony.—The Congress has accepted, as a general concept, the idea that the Nation's river basins should be developed under comprehensive and coordinated plans, and over the years it has made changes in the Flood Control Acts which tend to implement this concept. Yet much of the basic legislation was written when the Congress contemplated only single-purpose flood-control projects and this legislation stands side by side on the statute books with a declaration that it is the intent of Congress "to facilitate the consideration of projects on a basis of comprehensive and coordinated development * * * ".[21] These remnants of earlier single-purpose legislation also contrast strangely with the actions of Congress in directing the development of comprehensive plans for various regions.

It would be most helpful to the Federal agencies concerned if the Congress would enact a clear-cut statement of its major objectives and intent with respect to the development, utilization, and conservation of the water resource, and bring existing laws into harmony with that objective. This view was earlier expressed by the President's Water Resources Policy Commission in the following language: "In summary, sound planning for the development, utilization, and conservation of natural resources requires a broad mandate to do a comprehensive planning job * * *."[22] Similar statements have been made by nearly all other Federal commissions and commissions and committees which have been established to make formal reports on the Nation's water policies. Preparation and enactment of any broad statement of water-resources law is most difficult. Therefore the step-by-step procedure under which previous legislation has developed has much to commend it from a practical standpoint. This procedure has been followed in the past and could continue to be followed if the major objectives are established.

Over the years the Flood Control Acts have become the principal body of law governing the multiple-purpose development of the Nation's river basins. It would seem appropriate, therefore, for the Congress to incorporate in these acts the broad policy statement needed to clarify its intent, and to guide the Federal agencies toward the already accepted goal of full and efficient development of the Nation's resources under comprehensive and coordinated regional plans. At the same time it may be appropriate to broaden the designation of these acts. In fact even at the present time the name "Flood Control Acts" is a confusing and misleading designation for a body of law which encompasses, in addition to flood control: the development of hydroelectric power; the provision of water supplies for municipal and industrial purposes; the enhancement of recreational opportunities; and still other aspects of river basin development.

A needed shift in emphasis.—Consistent with the concept of optimum development of the Nation's rivers is the idea that reservoir systems should be planned with a view to regulating the rivers for all purposes. This subsidiary concept has taken on added importance during recent years as the result of a growing realization that in the foreseeable future the principal rivers of the Nation will have to be regulated to a degree which would have once been considered fantastic. In some regions industrial demands for water have already become so great that much higher dry-season flows are an immediate requirement. Also the use of the rivers to dispose of the wastes of rapidly growing cities and industrial complexes will require a high degree of regulation of major rivers in the future. It is obvious that the Flood Control Acts should be brought into harmony with this modern need for regulated rivers. In amendment of this body of law to achieve the ends previously discussed, the language used should be such as to make it possible for the responsible agencies to develop plans for reservoir systems which will meet the needs for all purposes.

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[21] This language first appeared in the Flood Control Act approved Dec. 22, 1944.

[22] "Water Policy for the American People," vol. 1 of the Report of the President's Water Resources Policy Commission, 1950, p. 53.

If a stream could be fully regulated, there would be no floods. Regulation is, in fact, the ultimate solution of the flood problem. A reservoir system capable of providing a high degree of regulation is simply a means of converting floods to a steady flow so that the stream will be of greater value for power generation, water supply, pollution abatement, navigation, and other purposes.

SUMMARY OF APPRAISAL

In the foregoing it has been shown that the body of law designated as the Flood Control Acts has been continuously modified over the years to better adapt it to meet changing problems and needs. This has made it possible for the program carried out under these acts to achieve much more than the original limited objective of Congress: the elimination of the greatest hazards to life and property at cities located in the major river valleys. The Flood Control Acts have, in fact, become the principal body of law under which the Nation is attempting to achieve optimum development of its river basins.

It would seem, therefore, that the changes suggested in this report are in harmony with the obvious intent of Congress to keep the Flood Control Acts abreast of the Nation's needs. Modification of existing laws is now far more important than it has been in the past, for the Nation has already passed into a new era in which it can no longer look forward to the exploitation of what once seemed to be an unlimited reserve of natural resources. Today our resources are, as it were, "under our feet," and the very existence of the Nation may depend upon the efficient use of those resources. Moreover, problems which seemed of little importance when the first general flood control legislation was enacted in 1936 have now become of primary importance. The previously mentioned need for regulated streams to meet rapidly accelerating demands for industrial water, and the disposal of wastes, is a striking example of the shift in emphasis.

In view of these rapid and radical changes a major objective of this appraisal has been to suggest to the Congress the ways in which it may still further modify the Flood Control Acts to make them responsive to emerging needs. It will be recognized that all of the modifications suggested would carry the Nation closer to an ultimate goal which has already been accepted by the Congress in principle: the goal of comprehensive and coordinated programs for the full development, efficient utilization, and careful husbandry of the resources of its major river basins.

SUPPLEMENTS

SUPPLEMENT A

DEFINITIONS OF IMPORTANT TERMS

As used by the Corps of Engineers in planning and evaluating flood control projects

The term "flood"

The term "flood" connotes the overflow of lands not normally covered by water, and which, therefore, are used—or are usable—by man. A flood may be caused by a temporary rise of the water level in a river, or other watercourse, and the consequent inundation of adjacent "bottomlands" (flood plain); or it may be caused by the temporary rise of lakes or oceans, with consequent inundation of border lands normally above water. For stream floods the rise in elevation is usually the result of an increased rate of flow attributable to storm rainfall or melting snow. For lakes and similar bodies of standing water the rise may result from abnormal tides, winds, or inflow. All damaging floods have two essential characteristics: (1) The inundation of land used or usable is temporary; and (2) the inundated land is adjacent to a river or stream channel or to an ocean, lake or other body of standing water. The flow of storm runoff over the surface of the land, before it collects in stream channels, causes a flood, but is not a flood of itself because it does not result from the overflow of a regular watercourse. The natural wetness or inundation of a swamp is not considered a flood because the inundated or marshy area must be reclaimed before it can be used.

Flood damage

"Flood damage" is, of course, the damage caused by floods. It follows from the foregoing definition of the term "flood" that flood damage must be caused by the temporary inundation of lands adjacent to a watercourse, lake or other area reserved for the conveyance or ponding of water. Such overflow may cause economic damage in the following ways:

(1) The water itself may damage buildings, crops, or other properties which it wets;

(2) The sediment carried by the water may be deposited on fields, in roads, or in buildings located within the wetted area;

(3) The velocity of the water may be high enough to cause damage by erosion of the flood plain (scour), or by destruction of buildings, fences, and other structures;

(4) The water, particularly if its velocity is high, may drown livestock.

The damages caused in the above ways are usually classified as follows for presentation in flood control survey reports:

(*a*) Urban and industrial damage.

(*b*) Agricultural damage (including damage to farm buildings).

(*c*) Highway, railroad, bridge, and related damages.

(*d*) Damage to public utilities.

These are direct physical losses. Floods may also result in—

1. Indirect economic damages (such as loss of time, disruption of production, and flood emergency activities).
2. Intangible damages, including loss of human life.

Flood damages do not include the destruction, or damaging, of land by bank cutting or by upland erosion. The former does not qualify as a flood damage because most destruction of land by bank cutting occurs when the stream is flowing at less than bank-full stages and hence is not in flood. Upland erosion is caused by overland flow which is not considered a flood damage, because it takes place whenever there is surface runoff. In fact, the great number of ordinary rains which produce no floods in the streams, produce much of the erosion. In this respect erosion is like bank cutting.

Flood control

The term "flood control" has come to be used as a general designation for projects undertaken to reduce flood damages. It is a somewhat misleading term because rarely does a project control floods in the sense that it entirely eliminates the possibility of damage. There is always chance of occurrence of a flood so large that damage may be suffered even below a major reservoir, and proceeding downstream from such reservoirs the probability of damage increases. Moreover, there is always some possibility that the capacity of an enlarged or leveed channel may be exceeded. In practice therefore, a flood control project is, in effect, an undertaking intended to reduce flood damages. For some projects the degree of reduction may be so high that the average annual flood damage is reduced to practically nothing. Other projects eliminate only the small frequent floods, thus leaving a significant fraction of the average annual damage, and—what is more important—the possibility of catastrophic damage when a great flood does occur. The term "flood control" is also the legal designation for projects authorized by the flood control acts. However, these acts have been expanded to cover nearly all phases of water resource development, and many projects authorized by legislation bearing the flood control label are multiple purpose is nature. For example, a project authorized by a flood control act may serve some or all of the following purposes: flood damage reduction; power production; improvement of navigation; provision of recreational opportunities; making possible changes in the use of land by irrigation, drainage or reduction of the flood hazard; provision of water for municipal and industrial use; abatement of pollution; and enhancement of the fish and wildlife resource. In planning, cost allocation and other technical aspects of water resource development it is, therefore, necessary to use a more precise definition of "flood control". For these purposes the term is used in the sense of flood damage reduction. Similarly, other purposes of projects authorized by the flood control acts are referred to by the type of benefit produced, and the cost of a project authorized by a flood control act may be allocated to any, or all, of the purposes itemized above.

Flood prevention

The term "flood prevention" has, like flood control, both a legal and a technical meaning. Projects under and pursuant to the Watershed Protection and Flood Prevention Act of 1954 (Public Law 566) are commonly referred to as flood prevention projects. These projects generally are systems of reservoirs, channel improvements and levees. Like similar projects undertaken pursuant to the Flood Control Acts, Public Law 566 projects may constitute multiple-purpose projects. They may: reduce flood damages; make possible changes in land use through irrigation, improved drainage, or reduction of flood hazard; provide water supply for municipalities; enhance fish and wildlife resources; provide recreational opportunities; reduce the rate of destruction of land by gullies or by bank cutting; and, to some degree, regulate the flows of headwater streams. The principal objective of the legislation authorizing flood prevention projects was (as is shown by the committee reports and floor debate on the bill which later became Public Law 566) the reduction of flood damage; just as this was the principal purpose of the projects authorized by the earlier flood control acts. However, like the flood control acts, Public Law 566 was soon converted to multiple-purpose legislation by amendatory legislation. Hence for purposes of project planning, cost allocation, and other technical aspects of water resource development, projects undertaken pursuant to Public Law 566 may be treated in the same way as projects undertaken pursuant to the flood control acts.

Like flood control the term "flood prevention" is actually a misnomer. The flood prevention works constructed under Public Law 566 do not prevent floods; they reduce flood damages by storing floodwaters in reservoirs or by increasing the capacity of channels. Flood prevention projects undertaken pursuant to Public Law 566 authorities are, as indicated previously, composed of engineering works similar in all respects, except size, to those works which are called flood control works when constructed under the authority of the flood control acts. Public Law 566 projects are constructed within the drainage basins (watersheds) of small headwater streams. They are small compared to projects constructed under the flood control acts for the simple reason that since the drainage basins are small, the volumes and rates of floodflows are relatively small.

Flood damage reduction benefits

The reduction of future flood damages was the original objective of both flood control and flood prevention projects. Flood damages are reduced by measures which confine floods or reduce flood stages, and thus decrease the frequency with which any particular portion of the flood plain is inundated. The benefits which result from these effects are of two kinds:

1. Those resulting from reductions in the flood damage as previously defined.

2. Those resulting from changes in the use of flood plain lands which are made possible because of the reduction in the frequency of flooding; that is, by reduction of the flood hazard.

The former type of benefit represents a reduction in a loss that will actually be suffered if the project is not undertaken. The latter is more in the nature of a reclamation benefit. It will be discussed under the heading "Changed land use benefits."

In determining the flood damage reduction benefits which would result from any contemplated project it is necessary to estimate what these damages would be in the future: (1) If the project is not carried out, and; (2) if it is carried out. The difference between these two estimates is the benefit creditable to the proposed project. It will be noted that past damages do not enter into economic evaluation except to the extent that they may indicate what future damages are likely to be. It is also important to note that future damages without the project must be determined for the use to which the flood plain will be put if the project is not undertaken.

Drainage benefits

One common method of reducing flood damages is to increase the capacity of the stream channel, thus reducing the frequency of out-of-bank flows. This measure sometimes improves the drainage of lands normally too wet for any use (swamps or marshes), or lands which can be used more intensively if the soil moisture content is reduced during the growing season. This enables the land to be put to more profitable use and in this way produces a drainage benefit. This benefit is obviously similar to the enhancement, or changed land use, benefit resulting from reduction of the flood hazard. But drainage has always been considered a form of land reclamation, and treating changed land use benefits attributable to improved drainage as a reclamation benefit has been a generally accepted practice. More specifically, the accepted practice is to consider projects which both reduce flood damages and improve as multiple-purpose undertakings and to allocate part of the cost to the flood damages reduction component and part to the drainage component thereof. The cost sharing proposed for the drainage components of such projects has, in general, been equivalent to the nominal cost sharing for single-purpose Federal irrigation projects; the local interests being required to assume about one-half of the part of the first cost allocated to drainage.

Changed land use benefits

In the two previous definitions reference was made to "enhancement," or "changed land use," benefits resulting from changes in the use of land made possible by either: (*a*) reduction in the frequency of flooding, or flood hazard, or; (*b*) reduction of excess soil moisture by improved drainage. It was stated that these are in the nature of reclamation benefits in the sense that reclamation makes it possible to put land for more profitable uses. The flood control acts have established a very definite cost-sharing policy for the flood damage reduction components of projects. They do not clearly and specifically deal with changed land use benefits resulting from reductions in the flood hazard, and not all with changed land use benefits resulting from reclamation by drainage.

One reason for the uncertainty as to the intent of Congress with respect to changed land use benefits is that at the time the Flood Control Act of 1936 was being hammered out by the Congress, great care was taken to distinguish between flood damage reduction and what was referred to by the Senate committee as reclamation. It was repeatedly stated that the protection of agricultural lands was not to be considered as flood control; that since it would make possible changes in land use it was properly reclamation. However, this distinction soon faded and a great many projects have been undertaken to reduce flood damages on agricultural lands. Moreover, it is perfectly proper to credit to a project undertaken primarily to reduce flood damages those benefits which result from making possible more profitable uses of flood plain lands. Yet there is a real difference between reducing flood damages and making it possible to convert flood plain lands to higher uses. Hence projects which produce both types of benefits are usually considered as multiple-purpose projects and costs are allocated to both purposes. The cost-sharing policy set by the flood control acts is then applied to the flood damage reduction component of such projects, but cost sharing for the second component (often called the enhancement component) is arrived at by an entirely different formula. Since in the 1936 and 1938 Flood Control Acts the Congress established a policy for only the flood damage reduction component of projects undertaken pursuant to the flood control acts, it has been considered necessary for the Chief Executive to establish the policy for the enhancement component. The policy established by the President is as set out in the Bureau of the Budget Circular No. A-47. It calls for non-Federal interests to assume one-half of the cost allocated to the "enhancement" (changed land use) component of projects. This policy was considered to be in line with the reclamation policy of Congress, since under the Reclamation Acts the Federal Government pays the interest cost of the amount allocated to reclamation, and the cost of interest over the 50-year repayment period is about half the total cost.[1]

The policy set by Circular A-47 as applicable to changed land use resulting from reduction in the flood hazard, is the same policy that the Corps of Engineers had previously used for changed land use resulting from improved drainage. As a matter of fact, Circular A-47 does not distinguish between the two types of benefits. A distinction would be necessary only in the event the Congress should establish a different cost-sharing policy for the two. This is mentioned because in discussions of the cost-sharing recommended for specific projects by committees of Congress there has been indication of a feeling that changed land use benefits attributable to a reduction in the flood hazard should be treated in the same way as flood damage reduction benefit for cost-sharing purposes, while changed land use resulting from improved drainage might well continue to be treated the same as a reclamation benefit. Nevertheless, no legislative action has been taken to establish a definite policy on this.

In determining benefits resulting from changed land use estimates are made of the net income from the land: (1) without changes in land use, and; (2) with the expected changes in use. Both of these estimates must be made for the floods which would be experienced with the project in operation. This insures that the changed land use benefit will not duplicate the benefit claimed for reduction of flood damages.

Definitions of floods used in planning and design.—The following are basic definitions used by the Corps of Engineers in planning and design of flood control improvements:

(1) The maximum possible flood is an estimated or hypothetical flood that represents the flood discharge that may be expected from the most severe combinations of critical meteorological and hydrological conditions that are considered reasonably possible in the region. The maximum possible flood is invariably larger than the maximum flood of record. It is used specifically as a criteria in spillway designs, to insure the safety of dams.

(2) The standard project flood is an estimated or hypothetical flood that might be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved, excluding extraordinarily rare combinations.

(3) The term "design flood" refers to the flood hydrograph or peak discharge value adopted as the basis for design and operation of a particular project after full consideration of flood characteristics, frequencies, and potentialities, and economic and other practical considerations. With reference to reservoirs, it may be applied to the most severe flood that a particular reservoir may be capable of controlling under an adopted plan of operation, but this is used usually only when the reservoir is provided primarily for protection of a specific damage center, or when the term is indicative of the basis for a flood control storage allocation. The design flood ordinarily is as large as sound economics indicates is warranted. It is often larger than the maximum of record, and it may approach the standard project flood, especially where hazards to life and health exist as in developed areas. However, it may be less than the maximum flood of record as when only cropland is protected and economic studies indicate that further increases in project size cannot be justified by the additional benefits.

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[1] Under reclamation law, however, parts of the reclamation cost may be covered by power revenues, and Circular A-47 does not permit this for the reclamation effects of projects which reduce flood damages.

SUPPLEMENT B

PROCEDURE UNDER THE FLOOD CONTROL ACTS

The regular procedure by which projects come into being under the flood control acts may be briefly outlined as follows:

Authorization of survey

The initial step is taken by groups suffering flood damages and is usually to call their problems to the attention of their representatives in Congress, and request them to seek authorization for a survey of the problem. This is accomplished by the inclusion in one of the flood control acts of a provision authorizing and directing the Secretary of the Army to cause the desired survey to be made under the direction of the Chief of Engineers. If a survey has previously been made, a review of the report thereon can be made without additional legislative authority if approved by resolution of either of the Public Works Committees of either House of Congress.

Preparation of survey report

When appropriations are made available for the authorized survey, after consideration by the Committees on Appropriations, the necessary investigations are made by one of the district engineers of the Corps of Engineers under the general supervision of a division engineer. Since a great many surveys may be authorized in any one year, and since funds and personnel for conduct of these studies are limited, it is not possible to prosecute all surveys immediately after authorization. Some years may elapse before it is possible to start the study. Surveys are proposed by the Corps of Engineers for undertaking as a part of annual budget requests on the basis of apparent urgency of the problem. The following steps are taken by the district engineer in the performance of this function.

a. Public hearing.—Early in the investigation the district engineer arranges to hold public hearings at which local interests are given the opportunity to state their needs and desires and to take part in the investigations. Additional hearings may be held at a later date, if found advisable, to describe and discuss plans of improvement that are under consideration with the various interests concerned.

b. Surveys and studies.—After the initial hearings and a reconnaissance, the district engineer and his staff assemble and analyze all necessary engineering and economic data necessary for project formulation.

c. Coordination.—Coordination with other Federal agencies and with State and local interests is an essential part of a study to insure that all interests are considered and to resolve as fully as possible all conflicts of needs and use. The district engineer carries out this coordination at the field level to the maximum extent practicable.

d. The survey report.—The district engineer prepares a written report which sets forth pertinent data on his investigations, together with his conclusions and recommendations for solution of the problem studied. Survey reports range from those which consider small local protection projects for a single area to comprehensive studies of a major river basin which consider flood control generally along with other needs of water resources development.

Review of report

a. The division engineer.—The division engineer supervises the investigation program of the districts in his division and participates to the extent necessary during the conduct of the investigations. After completion of the report by the district engineer, the division engineer makes a careful overall review and submits his recommendations to the Chief of Engineers, together with a draft of a public notice which indicates that a report has been completed by the field officers and summarizes the results of the study. Issuance of the public notice is approved by the Chief of Engineers after preliminary review by his staff to assure that the report is basically sound and in conformance with policy.

b. The Board of Engineers for Rivers and Harbors.—Upon approval of the public notice, the report is referred to the Board of Engineers for comprehensive review by the Board staff of engineering and economic considerations, and for careful consideration by Board members of policy applications, procedures, and recommendations. The Board may also hold public hearings if requested by local interests in appeal against or in support of the findings of the division engineer. After completion of analysis and review, the Board submits its report to the Chief of Engineers.

c. The Chief of Engineers.—The Chief of Engineers and his staff consider the reports of the Board of Engineers and of the division and district engineers, including all related papers and developments during the course of the investigations. Recommendations are examined from the standpoint of sound engineering and economics, and for conformity to law and policy. The proposed report of the Chief of Engineers is submitted to the Washington headquarters of other Federal agencies and to the Governors of the States concerned for review and comment as required by law and by Federal interagency coordination procedures. After receipt and consideration of their comments, the report of the Chief of Engineers is prepared and submitted to the Secretary of the Army together with all supporting papers.

d. The Secretary of the Army.—A review of the report is made by the Assistant Secretary of the Army with particular reference to its conformance with administrative policy. The Secretary then submits the report to the Bureau of the Budget for a statement on conformance of the report with the program of the President. Upon receipt of the comments of the Bureau of the Budget, the report, together with supporting papers, is submitted to the Congress by the Secretary of the Army.

Authorization proceedings

When they reach the Congress survey reports are referred to the Committees on Public Works. These committees hold public hearings on the proposals made in the reports. Ordinarily the committees accumulate a number of such proposals before preparing an omnibus bill authorizing their execution. These bills are processed through the Congress in the usual manner. When such a bill is enacted it becomes one of the series of flood control acts. Each of these acts authorizes the carrying out of specific projects, and the projects thus authorized are eligible for appropriation of funds for design and construction. The language used in the act becomes the basic legislative authority for the specific project to which it applies, and the authority provided for one project may vary considerably from that given for other projects. In other words the policy set by the specific authorizing language may possibly vary from general flood control policy. The acts often include items of broad general legislation.

Funding of authorized projects

At an appropriate time, funds for carrying out the detailed design and subsequent construction of specific projects are requested by the Corps of Engineers in an annual budget presentation. Such annual requests for starting, design, or construction are based upon recommendations of field offices as to merit and urgency. The Bureau of the Budget reviews these requests for inclusion in the President's budget. The Committees on Appropriations then hold public hearings prior to reporting their action on the appropriation bill. This bill is processed through Congress in the regular way and after it is enacted, the projects for which funds are appropriated may be initiated. Additional funds are requested from time to time until the project is finally completed.

Planning of authorized projects

Upon appropriation of the necessary funds by Congress, the district engineer proceeds with the detailed planning and design of the authorized improvement. This entails performance of studies to—

(*a*) Provide the basis for orderly design in preparation of plans and specifications, acquisition of lands, and negotiation of relocation agreements.

(*b*) Establish operating requirements and determine that the project will meet such requirements.

(*c*) Coordinate the project plan with views of other governmental agencies and local interests.

(*d*) Provide the basis for an up-to-date estimate of project cost.

(*e*) Bring the economic analysis of the project up to date.

(*f*) Facilitate the orderly programing of project funding and scheduling of detailed design and construction.

Construction of authorized projects

When funds are appropriated by Congress for the construction of specific projects, the district engineer directs the accomplishment of that work. Nearly all construction work is done under contract.

Operation and maintenance

Under existing law, local flood protection projects are turned over to non-Federal interests for operation and maintenance. The Corps of Engineers furnishes operating manuals to guide local interests in carrying out this responsibility, and makes periodic inspections to determine that the operation and maintenance are being carried out satisfactorily. Most flood control reservoirs and multiple-purpose water resource projects are operated and maintained by the Corps of Engineers at Federal expense.

Appraisal

It is obvious that the normal procedure outlined above is time consuming. The procedure, however, provides for thorough consideration and review at various stages of development and for full consideration by the Congress, the administration, and by States and local interests.

SUPPLEMENT C

FLOOD CONTROL PROJECTS OF THE CORPS OF ENGINEERS AS OF JUNE 30, 1960, CLASSIFIED BY REGION, STATE, AND TYPE OF PROJECT

PART I—COMPLETED PROJECTS

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER	
	NEW ENGLAND	
	CONNECTICUT	
	Local protection projects	
1	East Hartford	[1] 2,136
2	Folly Brook at Hartford	382
3	Hartford	6,457
6	Norwich	1,300
8	Winsted	172
	Reservoir projects	
4	Mansfield Hollow	6,378
	MASSACHUSETTS	
	Local protection projects	
2	Chicopee	[1] 1,434
3	Holyoke	[1] 3,418
5	Lowell	[1] 491
6	Northampton	[1] 960
7	Riverdale	1,137
8	Springdale	700
9	Springfield	[1] 932
11	West Springfield	[1] 1,579
19	Worcester	5,120
	Reservoir projects	
13	Barre Falls	2,002
1	Birch Hill	4,165
14	Buffumville	2,908
4	Knightville	3,217
15	East Brimfield	6,500
10	Tully	1,548
16	Hodges Village	4,510
	NEW HAMPSHIRE	
	Local protection projects	
4	Nashua	270
	Reservoir projects	
1	Blackwater	1,320
2	Edward MacDowell	2,017
3	Franklin Falls	7,922
5	Surry Mountain	1,732
7	Otter Brook	4,003
	RHODE ISLAND	
	Local protection projects	
1	Woonsocket	4,200
	VERMONT	
	Local protection projects	
1	Lamoille River channel improvement	50
	Reservoir projects	
4	East Barre (modification)	[2] 2,378
2	Union Village	4,003
8	Waterbury (modification)	[2] 860
9	Wrightsville (modification)	[2] 1,256
	Regional totals:	
	Local protection projects	30,738
	Reservoir projects	56,719
	All projects	87,457
	A. PROJECTS WITHOUT POWER—Continued	
	MIDDLE ATLANTIC	
	DISTRICT OF COLUMBIA	
	Local protection projects	
1	Washington, D.C., and vicinity	332
	MARYLAND	
	Local protection projects	
2	Anacostia River	5,951
3	Cumberland	15,521
	Reservoir projects	
1	Savage River	2,072
	MASSACHUSETTS	
	Local protection projects	
12	Adams	6,160
17	North Adams	15,000
	NEW JERSEY	
	Local protection project	
1	Mount Holly	284
	NEW YORK	
	Local protection projects	
1	Addison	827
4	Avoca	436
6	Bath	638
7	Binghamton	2,952
8	Canisteo	976
9	Corning	2,205
11	Elmira	6,745
12	Hoosick Falls	1,065
13	Hornell	4,243
15	Lisle	661
16	Monkey Run at Corning	1,117
21	Oxford	131
22	Painted Post	414
25	Village of Whitney Point	424
	Reservoir projects	
2	Almond	5,551
3	Arkport	1,910
10	East Sidney	5,867
26	Whitney Point	5,075
	PENNSYLVANIA	
	Local protection projects	
22	Allentown	1,710
6	Kingston-Edwardsville	4,472
11	Plymouth	1,860
14	Sunbury	6,076
15	Swoyersville-Forty Fort	2,692
18	Wilkes-Barre	3,789
17	Williamsport	12,820
	Reservoir projects	
19	Indian Rock	5,087
26	Gen. Edwin Jadwin Dam	4,000
28	Prompton	3,700
	Regional totals:	
	Local protection projects	99,507
	Reservoir projects	33,262
	All projects	132,769

See footnotes at end of table, p. 75.

PART I—COMPLETED PROJECTS—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER—Continued	
	SOUTH ATLANTIC AND EAST GULF	
	ALABAMA	
	Local protection projects	
1	Prattville	649
2	Tombigbee River	35
	GEORGIA	
	Local protection projects	
1	Augusta	643
2	Macon	390
3	Rome	308
	NORTH CAROLINA	
	Local protection projects	
1	Goldsboro	50
3	Pasquotank	79
2	Tar River	81
	Regional totals:	
	Local protection projects	2,395
	Reservoir projects	0
	All projects	2,395
	LOWER MISSISSIPPI	
	ARKANSAS	
	Local protection projects	
31	Calion	973
11	Little Missouri River channel improvement	355
22	Ozan Creek channel improvement	58
27	Terre Noire Creek	124
	LOUISIANA	
	Local protection projects	
6	Bayou Teche and Vermilion River	2,912
10	Lake Pontchartrain	1,440
18	Amite River and tributaries	3,360
	MISSISSIPPI	
	Local protection projects	
1	Big Black River	910
2	Homochitto River	205
	Regional totals:	
	Local protection projects	10,337
	Reservoir projects	0
	All projects	10,337
	SOUTHWEST AND WEST GULF	
	COLORADO	
	Local protection projects	
2	Creede	220
	LOUISIANA	
	Local protection projects	
12	Mermentau River	4,632
	NEW MEXICO	
	Local protection projects	
3	Rio Grande Floodway (Albuquerque unit)	3,155
	Reservoir projects	
2	Jemez Canyon	4,056
	TEXAS	
	Local protection projects	
11	Dallas Floodway	8,366
13	Fort Worth Floodway	3,878
15	Navidad and Lavaca River	355
	A. PROJECTS WITHOUT POWER—Continued	
	SOUTHWEST AND WEST GULF—Continued	
	TEXAS—continued	
	Reservoir projects	
7	Belton	12,825
1	Benbrook	10,941
2	Grapevine	8,343
8	Addicks	5,151
8	Barker	4,445
3	Hords Creek	2,175
4	Lavon	11,529
5	Lewisville	16,920
6	San Angelo	14,850
	Regional totals:	
	Local protection projects	20,606
	Reservoir projects	91,235
	All projects	111,841
	ARKANSAS, WHITE, RED BASINS	
	ARKANSAS	
	Local protection projects	
24	Black River, Knobel to Missouri line	446
3	Carden's Bottom Drainage District No. 2	920
4	Conway County Drainage and Levee District No. 1	187
5	Conway County Levee Districts Nos. 1, 2, 8	1,019
6	Conway County Levee District No. 6	391
35	Clarksville	273
7	Crawford County Levee District	2,002
8	Faulkner County	100
9	Fort Smith	1,078
10	Hempstead County Levee District No. 1	88
12	Little Rock	883
13	Little Rock to Pine Bluff (south bank)	1,735
14	Maniece Bayou	129
15	McLean Bottom Levee District No. 3	423
16	Levee near Dardanelle	198
17	Newport	314
19	North Little Rock	502
20	North Little Rock to Gillett (above Plum Bayou)	841
21	North Little Rock to Gillett (below Plum Bayou)	985
23	Pine Bluff	185
25	Roland Drainage District	270
26	Skaggs Ferry levees	81
34	Walnut Bayou	321
28	Van Buren	438
29	Village Creek	532
30	Levee west of Morrilton	1,191
	Reservoir projects	
2	Blue Mountain	4,771
18	Nimrod	3,772
	COLORADO	
	Local protection projects	
3	Templeton Gap at Colorado Springs	804
5	Pueblo	202
	Reservoir projects	
4	John Martin	15,138
	KANSAS	
	Local protection projects	
2	Hutchinson	3,498
3	Iola	22
15	Wichita and Valley Center	12,252
	Reservoir projects	
1	Fall River	10,455
13	Toronto	13,970
	LOUISIANA	
	Local protection projects	
1	Aloha-Rigolette	1,653
2	Bayou Bodcau, Red Chute, and Loggy Bayou	319
4	Bayou Pierre (lower portion)	300
5	Bayou Pierre near Shreveport	243
7	Columbia	205

See footnotes at end of table, p. 75.

PART I—COMPLETED PROJECTS—Contii.ued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER—Continued	
	ARKANSAS, WHITE, RED BASINS—Continued	
	LOUISIANA—continued	
	Local protection projects—Continued	
8	Grant Parish below Colfax	39
11	Natchitoches Parish	1,530
13	Pineville	232
14	Red River Parish	149
15	Red River near Shreveport	3,908
16	Saline Point	124
	Reservoir projects	
1	Bayou Bodcau	4,076
17	Wallace Lake	1,215
	MISSOURI	
	Local protection projects	
6	Black River, Poplar Bluff to Arkansas line	584
1	Carthage	347
3	Poplar Bluff and East Poplar Bluff	305
	Reservoir projects	
2	Clear Water	9,721
	NEW MEXICO	
	Reservoir projects	
1	Conchas	[1] 15,489
	OKLAHOMA	
	Local protection projects	
5	Jenks levee	345
7	Oklahoma City Floodway	8,051
9	Tulsa and West Tulsa levees	2,785
14	Enid Boggy Creek	918
	Reservoir projects	
12	Markham Ferry	6,927
1	Canton	10,328
2	Fort Supply	7,478
3	Great Salt Plains	4,599
4	Hulah	10,900
6	Altus [4]	[4] 1,130
8	Polecat Creek	2,374
10	Wister	10,428
	TEXAS	
	Reservoir projects	
12	Ferrells Bridge	11,729
17	Texarkana	33,740
	Regional totals:	
	Local protection projects	54,347
	Reservoir projects	178,240
	All projects	232,587
	OHIO BASIN	
	ILLINOIS	
	Local protection projects	
3	Brookport	603
16	Golconda	489
18	Harrisburg	850
36	Reevesville	600
38	Rosiclare	625
	INDIANA	
	Local protection projects	
3	Cannelton	1,941
4	Delphi	145
5	Gill Township levee	561
6	Jeffersonville-Clarksville	4,261
7	Lawrenceburg	2,433
8	Levee unit 8, White River	701
9	Lyford levee, Wabash River	267
10	Muncie	888
11	New Albany	5,465
12	Tell City	921
	Reservoir projects	
2	Cagles Mill	4,109
15	Mansfield	6,800

See footnotes at end of table, p. 75.

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER—Continued	
	OHIO BASIN—Continued	
	KENTUCKY	
	Local protection projects	
	Ashland	3,705
2	Covington	7,850
16	Catlettsburg	3,865
4	Hawesville	970
14	Barbourville	1,951
5	Jackson	131
17	Louisville	24,710
6	Maysville	6,490
7	Middlesboro	818
8	Newport	7,525
9	Paducah	4,754
10	Pineville	1,667
11	Russell	237
12	Taylorsville	373
13	Uniontown	1,071
	Reservoir projects	
3	Dewey	6,348
15	Buckhorn	10,300
19	Rough River	9,400
	NEW YORK	
	Local protection projects	
19	Olean	3,218
23	Portville	2,071
	OHIO	
	Local protection projects	
2	Cincinnati	10,118
4	Ironton	2,570
5	Massillon	8,140
8	Newark	786
9	Portsmouth-New Boston	9,820
14	Roseville	885
11	Wellsville	557
	Reservoir projects	
1	Berlin	6,289
3	Delaware	7,632
6	Mosquito Creek	4,035
7	Muskingum system (14 reservoirs)	40,800
10	Tom Jenkins	2,090
12	West Fork of Mill Creek	2,964
	PENNSYLVANIA	
	Local protection projects	
4	Johnsonburg	668
5	Johnstown Channel	8,865
7	Kittanning (pt. 1)	130
8	Latrobe	208
12	Punxsutawney	3,587
13	Reynoldsville	385
	Reservoir projects	
1	Conemaugh River	45,710
2	Crooked Creek	4,205
3	East Branch of the Clarion River	9,383
9	Loyalhanna	5,453
10	Mahoning Creek	6,421
16	Tionesta	5,213
20	Youghiogheny	9,675
	VIRGINIA	
	Local protection projects	
1	Galax	481
	WEST VIRGINIA	
	Local protection projects	
2	Ceredo-Kenova	2,700
3	Elkins	1,773
4	Huntington	7,110
5	Parkersburg	6,610
6	Point Pleasant	2,890
	Reservoir projects	
1	Bluestone	28,903
7	Sutton	34,600
	Regional totals:	
	Local protection projects	160,439
	Reservoir projects	250,830
	All projects	411,269

Part I—Completed Projects—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER—Continued	
	TENNESSEE BASIN	
	TENNESSEE	
	Local protection projects	
2	Lake City	473
	Regional totals:	
	Local protection projects	473
	Reservoir projects	0
	All projects	473
	UPPER MISSISSIPPI	
	ILLINOIS	
	Local protection projects	
1	Banner Special Drainage and Levee District	275
2	Big Lake Drainage and Levee District	145
4	Chouteau, Nameoka, and Venice Drainage and Levee Districts	186
5	Coal Creek Drainage and Levee District	1, 912
6	Columbia Drainage and Levee District	2, 820
7	Crane Creek Drainage and Levee District	69
8	Degognia and Fountain Bluff Drainage and Levee Districts	5, 874
9	East Cape Girardeau and Clear Creek Drainage and Levee Districts	1, 980
10	East Liverpool Drainage and Levee District	208
11	East Peoria Drainage and Levee District	280
13	Farmers Levee and Drainage District	156
14	Fort Chartres and Ivy Landing Drainage and Levee District	1, 150
15	Galena	844
17	Grand Tower Drainage and Levee District	4, 661
19	Harrisonville-Ivy Landing Drainage and Levee District	4, 363
20	Henderson County Drainage District No. 3	43
21	Hennepin Levee and Drainage District	110
22	Lacey, Langellier, West Matanzas, and Kerton Valley Drainage and Levee Districts	1, 235
23	Liverpool Drainage and Levee District	118
24	Mason and Menard Drainage District	94
25	Meredosia Lake and Willow Creek Drainage and Levee Districts	250
26	Miller Pond Drainage District	164
27	Mounds and Mound City	1, 133
28	Mouth of Sangamon River	761
29	Near Springfield on Sangamon River	98
30	North Alexander Drainage and Levee District	939
31	Oakford Special Drainage District	38
32	Pekin and La Marsh Drainage and Levee District	173
33	Penny Slough, Rock River	86
34	Prairie Du Rocher and vicinity	3, 871
35	Preston Drainage and Levee District	1, 890
37	Rocky Ford Drainage and Levee District	109
39	Seahorn Drainage and Levee District	32
40	Sny Island Levee and Drainage District	61
42 43	South Beardstown and Valley Drainage and Levee Districts	393
44	South Quincy Drainage and Levee District	61
41	Spring Lake Drainage and Levee District	186
45	Stringtown-Fort Chartres and Ivy Landing	2, 117
53	Wilson, Wenkle, Prairie Du Pont	5, 436
	Reservoir projects	
12	Farm Creek (2 reservoir system)	9, 838
	IOWA	
	Local protection projects	
2	Dry Run near Decorah	1, 707
3	Elkport	34
4	Green Bay Levee and Drainage District No. 2	299
11	Muscatine-Mad Creek	1, 220
6	Sabula	412
13	Upper Iowa River	878
	Reservoir projects	
8	Coralville	15, 487
	MINNESOTA	
	Local protection projects	
1	Aitkin	1, 673
	Reservoir projects	
2	Lac Qui Parle	927
	A. PROJECTS WITHOUT POWER—Continued	
	UPPER MISSISSIPPI—Continued	
	MISSOURI	
	Local protection projects	
4	Fabius River Drainage District	61
5	Gregory Drainage District	77
7	South River Drainage District	85
8	Union Township Drainage District	110
	Regional totals:	
	Local protection projects	50, 737
	Reservoir projects	26, 252
	All projects	76, 989
	GREAT LAKES	
	MICHIGAN	
	Local protection projects	
1	Mount Clemens	933
2	Red Run	953
3	Sebewaing River	366
	NEW YORK	
	Local protection projects	
5	Batavia	335
14	Lancaster	797
17	Montour Falls	1, 698
20	Moravia (Owasco Inlet and Outlet)	281
28	Wellsville	1, 014
	Reservoir projects	
18	Mount Morris	23, 366
24	Syracuse	3, 349
	Regional totals:	
	Local protection projects	6, 377
	Reservoir projects	26, 715
	All projects	33, 092
	RED RIVER OF THE NORTH	
	MINNESOTA	
	Local protection projects	
4	Red Lake and Clearwater Rivers	2, 766
	Reservoir projects	
5	Orwell	1, 917
3	Lake Traverse	1, 332
	NORTH DAKOTA	
	Reservoir projects	
1	Baldhill (Lake Ashtabula)	2, 653
2	Homme	1, 320
	Regional totals:	
	Local protection projects	2, 766
	Reservoir projects	7, 222
	All projects	9, 988
	MISSOURI BASIN	
	COLORADO	
	Reservoir projects	
1	Cherry Creek	14, 567
	IOWA	
	Local protection projects	
1	Council Bluffs	2, 558
5	Hamburg	236
10	Missouri River agricultural levees [5]	[5] 26, 500
	KANSAS	
	Local protection projects	
5	Abilene	1, 170
11	Salina	3, 760
	Reservoir projects	
4	Kanopolis	12, 328

See footnotes at end of table, p. 78.

PART I—COMPLETED PROJECTS—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER—Continued	
	MISSOURI BASIN—Continued	
	MONTANA	
	Local protection projects	
1	Forsyth	255
2	Glasgow	17
3	Havre	1, 826
4	Saco	68
	NEBRASKA	
	Local protection projects	
1	Bartley	118
3	Indianola	67
4	Niobrara	99
5	Omaha	5, 896
6	Platte River near Schuyler	75
	Reservoir projects	
2	Harlan County	45, 273
	NORTH DAKOTA	
	Local protection projects	
3	Mandan	687
5	Marmarth	210
	SOUTH DAKOTA	
	Local protection projects	
1	Belle Fourche	37
2	McCook Lake rehabilitation	148
	Reservoir projects	
3	Cold Brook	1, 610
	WYOMING	
	Local protection projects	
1	Grey Bull	249
	Regional totals:	
	Local protection projects	43, 976
	Reservoir projects	73, 778
	All projects	117, 754
	COLORADO BASIN	
	ARIZONA	
	Local protection projects	
1	Holbrook	335
	Reservoir projects	
1 A	Trilby Wash	1, 800
2	Painted Rock	19, 000
3	Whitlow Ranch	1, 897
	NEVADA	
	Reservoir projects	
1	[illegible]thews Canyon	688
2	[illegible] Canyon	714
	Regional totals:	
	Local protection projects	335
	Reservoir projects	24, 099
	All projects	24, 434
	GREAT BASIN	
	UTAH	
	Local protection projects	
1	Redmond and vicinity	919
2	Salt Lake City Jordan River	1, 150
	Regional totals:	
	Local protection projects	2, 069
	Reservoir projects	0
	All projects	2, 069
	A. PROJECTS WITHOUT POWER—Continued	
	CENTRAL VALLEY OF CALIFORNIA	
	CALIFORNIA	
	Local protection projects	
1	American River levees	2, 126
	Reservoir projects	
2	Big Dry Creek	1, 370
4	Cherry Valley[4]	[4] 9, 234
5	Farmington	3, 643
7	Isabella	21, 910
9	Merced County reservoir system (4 reservoirs)	2, 750
9A	North Fork (debris basin)	735
	Regional totals:	
	Local protection projects	2, 126
	Reservoir projects	39, 642
	All projects	41, 768
	CALIFORNIA COASTAL BASINS	
	CALIFORNIA	
	Local protection projects	
8	Lytle and Cajon Creeks	7, 612
10	Pajaro River	748
12	Riverside levees	2, 104
30	San Lorenzo River	4, 347
13	Ventura	1, 344
	Reservoir projects	
3	Brea	1, 190
6	Fullerton	411
11	Prado	9, 563
18A	Hansen	11, 330
18D	Lopez	685
18B	Sepulveda	6, 651
28	San Antonio	7, 010
18C	Santa Fe	12, 637
35	Whittier Narrows	32, 175
	Regional totals:	
	Local protection projects	16, 155
	Reservoir projects	81, 652
	All projects	97, 807
	COLUMBIA BASIN	
	IDAHO	
	Local protection projects	
1	Coeur d'Alene	153
2	Black Foot area	43
9	Black Foot River	340
5	Heise-Roberts area	1, 576
8	Kendrick-Potlatch	66
3	Lightning Creek at Clark Fork	43
10	Little Wood River	64
4	Shelley area	33
6	St. Maries on St. Joe River	358
	Reservoir projects	
11	Lucky Peak	19, 015
	OREGON	
	Local protection projects	
40	Amazon Creek	1, 242
1	Beaver Drainage District	275
2	Blind Slough Diking District (Clatsop No. 7)	163
4	Deer Island area	574
5	Clatsop Diking District No. 2	43
6	Clatsop Diking District No. 5	26
46	Clatsop Drainage District No. 6	56
8	Clatsop Drainage District No. 1	241
45	Clatsop Drainage District No. 1	22
10	John Day River area (Clatsop No. 14)	33
43	John Drainage District	151
11	Karlson Island Drainage District (Clatsop No. 10)	26
12	Knappa area (Clatsop County)	19
13	Lewis and Clark River area (Clatsop No. 8 and 11)	158

See footnotes at end of table, p. 75.

Part I—Completed Projects—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	A. PROJECTS WITHOUT POWER—Continued	
	COLUMBIA BASIN—Continued	
	OREGON—continued	
	Local protection projects—Continued	
14	Magruder Drainage District	61
15	Malheur Improvement District on Snake River	56
16	Marshland Drainage District	40
17	Midland Drainage District	78
47	Midland Drainage District No. 1	110
18	Mill Four Drainage District on Yaquina River	118
19	Milton-Freewater on Walla Walla River	890
20	Multnomah Drainage District No. 1	611
21	Nehalem	46
22	Pendleton on Umatilla River	143
49	Pendleton Umatilla River	316
23	Peninsula Drainage District No. 1	211
24	Peninsula Drainage District No. 2	241
25	Rainier Drainage District	48
26	Sandy Drainage District	130
27	Sauvie Island Drainage District	1, 642
28	Scappoose Drainage District	424
29	Tenasillohe Island Diking District (Clatsop No. 6)	134
30	Umpqua River (6 locations)	429
31	Walluski River Area (Clatsop No. 13)	67
32	Warrenton Diking District No. 1	70
33	Warrenton Diking District No. 2	117
34	Warrenton Diking District No. 3	75
35	Webb District Improvement Co	85
36	Westland District Improvement Co	206
38	Woodson Drainage District	23
37	Westport District	41
48	Woodson Drainage District	88
39	Youngs River area (Clatsop No. 9)	249
	Reservoir projects	
3	Cottage Grove	2, 373
7	Dorena	13, 517
9	Fern Ridge	4, 496
	WASHINGTON	
	Local protection projects	
1	Castle Rock	105
2	Consolidated Diking and Improvement District No. 1	163
3	Cowlitz County Drainage Improvement District	42
4	Deep River area	70
11	Diking and Improvement District No. 1	27
9	Diking and Improvement District No. 13	26
8	Diking and Improvement District No. 2	121
7	Diking and Improvement District No. 5	161
6	Diking and Improvement District No. 11	173
5	Diking and Improvement District No. 4	170
10	Diking Districts No. 1 and 3	259
20	Randle area, Cowlitz River	151
14	Skamokawa Creek area	179
17	Upper Grays River area	61
18	Yakima	381
	Reservoir projects	
12	Mill Creek	2, 162
	Regional totals:	
	Local protection projects	14, 534
	Reservoir projects	41, 563
	All projects	56, 097
	NORTH PACIFIC COASTAL BASINS	
	WASHINGTON	
	Local protection projects	
15	Stillaguamish River	221
16	Tacoma	3, 949
	Reservoir projects	
13	Mud Mountain	13, 209
	Regional totals:	
	Local protection projects	4, 170
	Reservoir projects	13, 209
	All projects	17, 379
	A. PROJECTS WITHOUT POWER—Continued	
	HAWAII BASINS	
	HAWAII	
	Local protection projects	
1	Hanapepe River	455
	Regional totals:	
	Local protection projects	455
	Reservoir projects	0
	All projects	455
	ALASKA BASINS	
	ALASKA	
	Local protection projects	
1	Fairbanks	557
2	Gold Creek	458
3	Lowell Creek	328
4	Salmon River	34
	Regional totals:	
	Local protection projects	1, 377
	Reservoir projects	0
	All projects	1, 377
	B. PROJECTS WITH POWER	
	(Multiple-purpose projects)	
	NEW ENGLAND	
	None.	
	MIDDLE ATLANTIC	
	VIRGINIA	
3	John H. Kerr (total cost, $86,475)	17, 883
4	Philpott (total cost, $13,340)	6, 489
	Regional total	24, 372
	SOUTH ATLANTIC AND EAST GULF	
	GEORGIA	
4	Allatoona (total cost, $31,321)	6, 888
5	Buford (total cost, $44,290)	3, 472
6	Clark Hill (total cost, $79,048)	3, 668
	Regional total	14, 028
	LOWER MISSISSIPPI	
	ARKANSAS	
42	Blakely Mountain (total cost, $30,956)	7, 674
44	Narrows (total cost, $12,726)	7, 363
	Regional total	15, 037
	SOUTHWEST AND WEST GULF	
	TEXAS	
30	Whitney Reservoir (total cost, $40,579)	30, 195
	Regional total	30, 195
	ARKANSAS, WHITE, AND RED BASINS	
	ARKANSAS	
43	Bull Shoals (total cost, $75,264)	28, 717
45	Norfolk (total cost, $28,642)	15, 538
	OKLAHOMA	
21	Denison (total cost, $60,090)	39, 942
22	Fort Gibson (total cost, $41,063)	24, 876
23	Tenkiller Ferry (total cost, $22,115)	10, 914

See footnotes at end of table, p. 75.

PART I—COMPLETED PROJECTS—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control
	B. PROJECTS WITH POWER—Continued	
	ARKANSAS, WHITE, AND RED BASINS—Continued	
	TEXAS	
21	Denison modification No. 1	[3] 3,058
	Regional total	123,045
	OHIO BASIN	
	KENTUCKY	
27	Wolf Creek (total cost, $79,029)	19,599
	TENNESSEE	
4	Center Hill (total cost, $44,438)	11,936
5	Dale Hollow (total cost, $25,921)	9,536
	Regional total	41,071
	TENNESSEE BASIN	
	None.	
	UPPER MISSISSIPPI	
	None.	
	GREAT LAKES	
	None.	
	RED RIVER OF THE NORTH	
	None.	
	MISSOURI BASIN	
	MONTANA	
9	Fort Peck (total cost, $134,200)	28,400
	Regional total	28,400
	COLORADO BASIN	
	None.	
	GREAT BASIN	
	None.	
	B. PROJECTS WITH POWER—Continued	
	CENTRAL VALLEY OF CALIFORNIA	
	CALIFORNIA	
44	Folsom (total cost, $62,855)	23,589
	Regional total	23,589
	CALIFORNIA COASTAL BASINS	
	None.	
	COLUMBIA BASIN	
	IDAHO	
16	Albeni Falls (total cost, $30,720)	169
	OREGON	
77	Detroit (total cost, $62,730)	19,471
78	Lookout Point (total cost, $87,870)	43,405
	Regional total	63,045
	NORTH PACIFIC COASTAL BASINS	
	None.	
	PART I—SUMMARY	
	A. WITHOUT POWER	
	Local protection projects	523,919
	Reservoir projects	944,418
	All projects	1,468,337
	B. WITH POWER	
	All projects	362,782
	Total, completed projects	1,831,119

PART II—PROJECTS UNDER CONSTRUCTION

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER		
	NEW ENGLAND		
	CONNECTICUT		
	Reservoir projects		
8	Hall Meadow Brook	2,210	264
9	Mad River	5,970	286
10	Thomaston	14,400	12,853
	MASSACHUSETTS		
	Reservoir projects		
18	West Hill	2,230	1,497
20	Westville	6,760	1,968
	NEW HAMPSHIRE		
	Reservoir projects		
6	Hopkinton-Everett	25,700	6,035
	VERMONT		
	Reservoir projects		
3	Ball Mountain	10,300	8,077
5	North Hartland	6,610	5,875
6	North Springfield	6,580	6,049
7	Townshend	7,070	5,516
	Regional totals:		
	Local protection projects	0	
	Reservoir projects	87,830	
	All projects	87,830	48,420
	MIDDLE ATLANTIC		
	NEW YORK		
	Local protection projects		
27	Endicott-Johnson City and Vestal	6,000	5,665
	A. PROJECTS WITHOUT POWER—Continued		
	MIDDLE ATLANTIC—Continued		
	PENNSYLVANIA		
	Local protection projects		
24	Bethlehem	9,300	1,108
	Reservoir projects		
23	Bear Creek	11,100	10,033
27	Kettle Creek	6,600	3,007
29	Stillwater	5,900	5,445
	Regional totals:		
	Local protection projects	15,300	
	Reservoir projects	23,600	
	All projects	38,900	25,258
	SOUTH ATLANTIC AND EAST GULF		
	FLORIDA		
	Local protection projects		
1	Central and southern Florida	224,200	57,312
	NORTH CAROLINA		
	Reservoir projects		
4	Wilkesboro	8,500	1,296
	Regional totals:		
	Local protection projects	244,200	
	Reservoir projects	8,500	
	All projects	252,700	58,608

See footnotes at end of table, p. 75.

Part II—Projects Under Construction—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	LOWER MISSISSIPPI		
	ARKANSAS, ILLINOIS, KENTUCKY, LOUISIANA, MISSISSIPPI, MISSOURI, AND TENNESSEE—MISSISSIPPI RIVER AND TRIBUTARIES PROJECT [6]		
	Local protection component		
	Mississippi River and tributaries project	1, 036, 280	753, 544
	Reservoir component		
	Mississippi River and tributaries project (5 reservoirs—Arkabutla, Enid, Grenada, Sardis, Wappapello: These components of the Mississippi River and tributaries project are essentially complete)	82, 720	77, 856
	LOUISIANA		
	Local protection projects		
	Ouchita River levees	3, 599	3, 299
	TENNESSEE		
	Local protection projects		
3	Memphis (Wolf River)	11, 200	11, 148
	Regional totals:		
	Local protection projects	1, 051, 079	----------
	Reservoirs	82, 720	----------
	All projects	1, 133, 799	845, 847
	SOUTHWEST AND WEST GULF		
	NEW MEXICO		
	Local protection projects		
5	Albuquerque	11, 700	372
	Reservoir projects		
4	Abiquiu	17, 900	9, 919
7	Two Rivers	6, 900	463
	TEXAS		
	Local protection projects		
8	Buffalo Bayou	42, 504	13, 029
16	San Antonio	16, 800	2, 812
	Reservoir projects		
9	Canyon	16, 700	4, 821
14	Navarro Mills	10, 100	1, 243
19	Proctor	18, 000	618
18	Waco	37, 300	542
	Regional totals:		
	Local protection projects	71, 004	----------
	Reservoir projects	106, 900	----------
	All projects	177, 904	33, 819
	ARKANSAS, WHITE, AND RED BASINS		
	ARKANSAS		
	Local protection projects		
32	McKinney Bayou and Barkman Creek	1, 390	722
33	Red River levees below Denison	10, 000	8, 128
	KANSAS		
	Reservoir projects		
16	Council Grove	13, 700	570
6	John Redmond	32, 800	2, 162
	OKLAHOMA		
	Reservoir projects		
11	Keystone	111, 000	20, 841
13	Oologah	35, 100	30, 196
	A. PROJECTS WITHOUT POWER—Continued		
	ARKANSAS, WHITE, AND RED BASINS—Continued		
	TEXAS		
	Reservoir projects		
10	Cooper	15, 200	2, 322
	Regional totals:		
	Local protection projects	11, 390	----------
	Reservoir projects	207, 800	----------
	All projects	219, 190	64, 941
	OHIO BASIN		
	ILLINOIS		
	Local protection projects		
51	New Harmony	646	298
	INDIANA		
	Local protection projects		
1	Brevoort levee	2, 350	1, 236
13	Evansville	13, 600	2, 627
16	Vincennes	4, 960	3, 574
14	Indianapolis	11, 100	1, 867
	KENTUCKY		
	Reservoir projects		
18	Nolin	14, 800	2, 589
20	No. 2 Barren	22, 200	1, 204
	OHIO		
	Reservoir projects		
13	Dillon	30, 700	26, 477
15	West Branch Mahoney	9, 320	760
	PENNSYLVANIA		
	Local protection projects		
25	Bradford	8, 000	6, 623
30	Brookville	1, 420	569
	Reservoir projects		
21	Allegheny	119, 000	4, 098
31	Shenango	29, 400	912
	VIRGINIA		
	Reservoir projects		
2	John W. Flannagan (Pound)	19, 200	1, 732
	WEST VIRGINIA		
	Local protection projects		
8	East Rainelle	950	546
9	Princeton	1, 160	[illegible]
	Reservoir projects		
10	Summersville	50, 800	2, 635
	Regional totals:		
	Local protection projects	44, 186	----------
	Reservoir projects	295, 420	----------
	All projects	339, 606	58, 309
	TENNESSEE BASIN		
	None.		
	UPPER MISSISSIPPI		
	ILLINOIS		
	Local protection projects		
46	Beardstown	5, 970	2, 900
48	Bear Creek Drainage District	4, 934	4, 404
49	Drury Drainage District	1, 590	575
50	East St. Louis	23, 700	13, 451
56	Henderson River	1, 750	639
55	Hunts and Lima Lake Drainage District	5, 680	1, 080
52	Sny Basin	22, 500	1, 866
54	Wood River Drainage and Levee District	15, 600	12, 226

See footnotes at end of table, p. 75.

Part II—Projects Under Construction—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	UPPER MISSISSIPPI—Continued		
	ILLINOIS—continued		
	Reservoir projects		
47	Carlyle	40,700	4,379
	IOWA		
	Local protection projects		
12	Muscatine Id. Levee District	4,000	1,231
	Reservoir projects		
14	Redrock	72,000	2,730
	MISSOURI		
	Local protection projects		
10	Canton	1,470	986
11	Cape Girardeau	5,570	4,456
16	Des Moines and Mississippi River Levee District	1,760	558
12	Fabius River Drainage District	1,740	1,269
13	Perry County Drainage and Levee Districts, Nos. 1, 2, and 3	7,060	5,315
15	St. Louis	120,000	7,033
	Reservoir projects		
9	Bear Creek	2,320	1,398
	Regional totals:		
	Local protection projects	223,324	----------
	Reservoir projects	115,020	----------
	All projects	338,344	66,496
	GREAT LAKES		
	MICHIGAN		
	Local protection projects		
4	Battle Creek	6,930	4,198
	Regional totals:		
	Local protection projects	6,930	----------
	Reservoir projects	0	----------
	All projects	6,930	4,198
	RED RIVER OF THE NORTH		
	MINNESOTA		
	Local protection projects		
5	Red River of North	4,283	3,915
6	Rutty Brook and Lost River	786	406
	Regional totals:		
	Local protection projects	5,069	----------
	Reservoir projects	0	----------
	All projects	5,069	4,321
	MISSOURI BASIN		
	IOWA		
	Local protection projects		
9	Little Sioux River	15,500	9,197
7	Chariton River	4,050	1,135
	KANSAS		
	Local protection projects		
7	Kansas City	44,100	39,364
8	Manhattan	3,100	538
9	Ottawa	4,660	2,564
12	Topeka	18,400	6,464
	Reservoir projects		
10	Pomona	14,100	2,408
14	Tuttle Creek	83,700	58,078
17	Wilson	18,800	903
	MISSOURI		
	Reservoir projects		
14	Pomme De Terre	16,100	10,133
	A. PROJECTS WITHOUT POWER—Continued		
	MISSOURI BASIN—Continued		
	NEBRASKA		
	Local protection projects		
8	Gering Valley	1,470	386
7	Missouri River, Kenslers Bend to Sioux City	11,300	10,530
	NORTH DAKOTA		
	Local protection projects		
4	Lower Heart River	2,200	1,364
	SOUTH DAKOTA		
	Local protection projects		
4	Sioux Falls	5,470	5,270
	Reservoir projects		
3	Fall River	3,350	1,094
	WYOMING		
	Local protection projects		
3	Sheridan	1,800	740
	Regional totals:		
	Local protection projects	112,050	----------
	Reservoir projects	136,050	----------
	All projects	248,100	150,768
	COLORADO BASIN		
	None.		
	GREAT BASIN		
	NEVADA		
	Local protection projects		
3	Truckee River and tributaries	1,200	801
	Regional totals:		
	Local protection projects	1,200	----------
	Reservoir projects	0	----------
	All projects	1,200	801
	CENTRAL VALLEY OF CALIFORNIA		
	CALIFORNIA		
	Local protection projects		
19	Lower San Joaquin River and tributaries	13,100	3,832
20	Middle Creek	1,962	1,559
26	Sacramento River, major and minor tributaries	24,200	4,715
25	Sacramento River	78,200	64,008
	Reservoir projects		
14	Black Butte	18,000	3,462
23	New Hogan	17,600	1,760
22	Pine Flat	40,850	39,130
32	Success	14,200	11,612
33	Terminus	21,500	11,487
	Regional totals:		
	Local protection projects	117,462	----------
	Reservoir projects	112,150	----------
	All projects	229,612	141,565
	CALIFORNIA COASTAL BASINS		
	CALIFORNIA		
	Local protection projects		
16	Devil, East Twin, Warm, and Lytle Creeks	7,800	4,808
17	Eel River	944	743
18	Los Angeles County drainage area	286,697	176,207
21	Mill Creek	910	407
27	San Antonio and Chino Creek	10,900	9,564
34	San Jacinto River	4,040	434
29	San Lorenzo Creek	5,150	3,542
36	Santa Clara River	2,140	1,835
31	Santa Maria Valley	7,190	2,379

See footnotes at end of table, p. 75.

PART II—PROJECTS UNDER CONSTRUCTION—Continued

[Thousands of dollars]

Map No.	Project designation	Total first cost flood control	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	CALIFORNIA COASTAL BASINS–Con.		
	CALIFORNIA—continued		
	Reservoir projects		
15	Carbon Canyon	5,150	3,943
24	Russian River	14,002	11,483
	Regional totals:		
	Local protection projects	325,771	------------
	Reservoir projects	19,152	------------
	All projects	344,923	215,345
	COLUMBIA BASIN		
	IDAHO		
	Local protection projects		
7	Portneuf River and Marsh Creek	1,390	103
	OREGON		
	Local protection projects		
41	Malheur River	423	311
42	Johnson Creek	639	157
44	Multnomah County Drainage District No. 1	1,740	1,150
50	Willamette bank protection	12,400	7,820
	WYOMING		
	Local protection projects		
2	Jackson Hole	2,480	1,436
	Regional totals:		
	Local protection projects	19,072	------------
	Reservoir projects	0	------------
	All projects	19,072	10,977
	NORTH PACIFIC COASTAL BASINS		
	WASHINGTON		
	Reservoir projects		
19	Howard A. Hanson	35,500	29,037
	Regional totals:		
	Local protection projects	0	------------
	Reservoir projects	35,500	------------
	All projects	35,500	29,037
	ALASKA BASINS		
	None.		
	HAWAII BASINS		
	None.		
	B. PROJECTS WITH POWER		
	NEW ENGLAND		
	None.		
	MIDDLE ATLANTIC		
	None.		
	SOUTH ATLANTIC AND EAST GULF		
	GEORGIA		
7	Hartwell (total cost, $94,600)	3,930	2,275
	Regional total	3,930	2,275
	LOWER MISSISSIPPI		
	None.		
	SOUTHWEST AND WEST GULF		
	TEXAS		
31	McGee Bend (total cost, $57,400)	8,013	2,216
	Regional total	8,013	2,216
	B. PROJECTS WITH POWER—Con.		
	ARKANSAS, WHITE, AND RED BASINS		
	ARKANSAS		
46	Beaver (total cost, $56,100)	6,227	316
47	Greers Ferry (total cost, $50,300)	14,423	4,011
	MISSOURI		
22	Table Rock (total cost, $66,100)	13,999	13,707
	OKLAHOMA		
24	Eufaula (total cost, $141,000)	59,291	8,967
	Regional total	93,940	27,001
	OHIO BASIN		
	KENTUCKY		
28	Barkley (total cost, $182,000)	57,970	10,515
	Regional total	57,970	10,515
	TENNESSEE BASIN		
	None.		
	UPPER MISSISSIPPI		
	None.		
	GREAT LAKES		
	None.		
	RED RIVER OF THE NORTH		
	None.		
	MISSOURI BASIN		
	NEBRASKA		
6	Gavins Point (total cost, $49,200)	7,500	7,227
	NORTH DAKOTA		
7	Garrison (total cost, $294,000)	51,900	50,216
	SOUTH DAKOTA		
5	Fort Randall (total cost, $193,000)	39,237	38,316
7	Oahe (total cost, $380,000)	51,700	27,747
	Regional total	150,337	123,506
	COLORADO BASIN		
	None.		
	GREAT BASIN		
	None.		
	CENTRAL VALLEY OF CALIFORNIA		
	None.		
	CALIFORNIA COASTAL BASINS		
	None.		
	COLUMBIA BASIN		
	OREGON		
79	Cougar (total cost, $49,200)	36,654	14,594
80	Hills Creek (total cost, $46,100)	26,192	18,687
81	John Day (total cost, $418,000)	12,540	911
	Regional total	75,386	34,192
	NORTH PACIFIC COASTAL BASINS		
	None.		
	ALASKA BASINS		
	None.		
	HAWAII BASINS		
	None.		
	PART II—SUMMARY		
	A. WITHOUT POWER		
	Local protection projects	2,248,037	1,304,912
	Reservoir projects	1,230,642	453,198
	All projects	3,478,679	1,758,110
	B. WITH POWER		
	All projects	389,576	199,705
	Total, projects under construction	3,868 255	1,957,815

See footnotes at end of table, p. 75.

Part III—Projects Authorized But Not Yet Under Construction

[Does not include authorized projects which have been classified as "Deferred" or "Inactive"]

[Thousands of dollars]

Map No.	Project designation	Total estimated first cost	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER		
	NEW ENGLAND		
	CONNECTICUT		
	Reservoir projects		
10	East Branch (Housatonic River)	2,010	20
	MASSACHUSETTS		
	Local protection projects		
22	New Bedford—Fairhaven and Acushnet (hurricane protection)	11,500	700
	Reservoir projects		
21	Littleville	5,490	116
	NEW YORK		
	Local protection projects		
40	South Amsterdam	1,500	7
	RHODE ISLAND		
	Local protection projects		
2	Fox Point Barrier-Narragansett Bay (hurricane protection)	11,426	895
	VERMONT		
	Local protection projects		
12	Rutland	5,530	215
14	Waterbury	4,400	6
	Reservoir projects		
10	Gaysville	20,000	10
11	Island	4,900	10
13	Victory	1,900	113
	Regional totals:		
	Local protection projects	34,356	
	Reservoir projects	34,300	
	All projects	68,656	2,092
	MIDDLE ATLANTIC		
	DISTRICT OF COLUMBIA		
	Local protection projects		
2	Washington, D.C., and vicinity (new project)	2,130	15
	NEW YORK		
	Local protection projects		
30	Cortland	355	5
34	Herkimer	765	55
37	Nichols	820	49
	Reservoir projects		
31	Davenport Center	13,380	291
32	Genegantslet	9,100	222
41	South Plymouth	9,410	110
42	West Oneonta	14,100	194
	PENNSYLVANIA		
	Local protection projects		
35	Elkland	1,440	20
40	Tyrone	9,400	249
	Reservoir projects		
32	Blanchard	26,500	18
33	Cowanesque	35,000	60
34	Curwensville	22,500	469
38	Tioga-Hammond	65,700	120
	Regional totals:		
	Local protection projects	14,910	
	Reservoir projects	195,690	
	All projects	210,600	1,877
	A. PROJECTS WITHOUT POWER—Continued		
	SOUTH ATLANTIC AND EAST GULF		
	ALABAMA		
	Local protection projects		
3	Montgomery	1,420	78
	MISSISSIPPI		
	Local protection projects		
3	Tombigbee River channel improvement	24,100	119
	NORTH CAROLINA		
	Local protection projects		
5	Pantego and Cucklers Creek	536	63
	Regional totals:		
	Local protection projects	26,056	
	Reservoir projects	0	
	All projects	26,056	260
	LOWER MISSISSIPPI		
	ARKANSAS		
	Local protection projects		
41	Posten Bayou	560	3
	LOUISIANA		
	Local protection projects		
19	Bayou Bartholomew	2,440	2
20	Bayou Chevreuil	556	54
	Regional totals:		
	Local protection projects	3,556	
	Reservoir projects	0	
	All projects	3,556	59
	SOUTHWEST AND WEST GULF		
	NEW MEXICO		
	Local protection projects		
8	Bluewater Floodway	475	10
9	Carlsbad and vicinity	2,120	37
13	Rio Grande Floodway—Espanola unit	880	2
14	Rio Grande Floodway—Middle Valley unit	5,700	10
12	Socorro and vicinity	3,510	153
	Reservoir projects		
10	Los Esteros (plus modification Alamogordo Dam)	9,500	420
11	Chamita (low dam)	19,000	331
	TEXAS		
	Local protection projects		
20	Burleson County Improvement District	3,410	
21	Eastland on Leon River	306	3
29	Kenedy	400	41
26	Pecos	2,660	109
28	Texas City (hurricane protection)	6,280	171
	Reservoir projects		
22	Ferguson	23,600	28
23	Gonzales	18,600	68
24	Lampasas	32,400	380
25	Laneport	27,200	34
27	Somerville	15,900	180
	Regional totals:		
	Local protection projects	25,741	
	Reservoir projects	146,200	
	All projects	171,941	1,985

See footnotes at end of table, p. 75.

PART III—PROJECTS AUTHORIZED BUT NOT YET UNDER CONSTRUCTION—Continued

[Thousands of dollars]

Map No.	Project designation	Total estimated first cost	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	ARKANSAS, WHITE, RED BASINS		
	ARKANSAS		
	Local protection projects		
39	Holla Bend Bottom	370	5
	Reservoir projects		
36	DeQueen	9, 510	5
37	Dierks	8, 530	5
38	Gillham	10, 100	84
40	Millwood	54, 400	550
	COLORADO		
	Local protection projects		
6	Trinidad Floodway (not to be constructed if Trinidad Reservoir is constructed)	2, 340	90
	Reservoir projects		
7	Trinidad (construction will abrogate authorization of floodway above)	20, 400	168
	KANSAS		
	Reservoir projects		
18	Cedar Point	6, 570	17
19	Elk City	22, 200	330
25	Marion	8, 240	45
	OKLAHOMA		
	Reservoir projects		
15	Boswell	24, 100	141
16	Broken Bow	10, 700	290
17	Hugo	20, 900	70
18	Lukfata	15, 100	58
19	Pensacola [1]	2, 090	52
20	Pine Creek	15, 400	87
	Regional totals:		
	Local protection projects	2, 710	----------
	Reservoir projects	228, 240	----------
	All projects	230, 950	2, 006
	OHIO BASIN		
	ILLINOIS		
	Local protection projects		
58	Bonpas Creek	628	5
60	England Pond levee	700	8
66	Levee unit 1, Little Wabash River	2, 690	9
37	Levee unit 1, Wabash River	4, 170	4
68	Levee unit 2, Little Wabash River	1, 730	8
69	Levee units 3 and 4, Wabash River	8, 310	8
73	Rochester and McClearys Bluff levee	1, 080	10
74	Russell and Allison levees	4, 960	6
75	Saline River and tributaries	6, 330	93
81	Tri-Pond levee	1, 130	12
	INDIANA		
	Local protection projects		
17	Adams levee	278	3
19	Deer Creek Prairie levee	203	3
20	Fletcher and Sunshine Gardens levee	522	14
21	Greenfield Bayou levee	2, 000	10
23	Island levee	1, 620	12
24	Levee unit 1, White River	2, 040	10
30	Levee unit 17, Wabash River	804	8
26	Levee unit 2, East Fork of White	682	11
25	Levee unit 2, Wabash River	3, 760	4
27	Levee unit 3, East Fork of White	3, 410	4
28	Levee unit 5, Wabash River	10, 500	96
29	Levee unit 7, White River	1, 400	11
31	Mason J. Niblack levee	3, 300	130
37	Racoon Creek levee	405	8
36	Sugar Creek levee	338	18
35	West Terre Haute levee and pumping plant	502	35
	Reservoir projects		
18	Brockville	20, 400	10
22	Huntington	15, 100	52
32	Mississinewa	23, 300	174
33	Monroe	5, 260	134
34	Salamonie	16, 400	174

See footnotes at end of table, p. 75.

Map No.	Project designation	Total estimated first cost	Appropriations through June 30 1960
	A. PROJECTS WITHOUT POWER—Continued		
	OHIO BASIN—Continued		
	KENTUCKY		
	Local protection projects		
22	Lewisport	581	2
25	Sturgis	750	4
26	Vanceburg	2, 280	2
	Reservoir projects		
21	Fishtrap	41, 700	326
24	Green No. 2	8, 980	66
	NEW YORK		
	Local protection projects		
29	Allegany	1, 050	7
36	Lake Chautauqua	5, 980	112
	OHIO		
	Local protection projects		
16	Adena	276	20
18	Dillonville	379	26
21	Middleport	5, 750	12
	Reservoir projects		
17	Caesar Creek	8, 080	10
19	East Fork	11, 900	74
20	Frazeyburg	6, 800	8
	PENNSYLVANIA		
	Local protection projects		
36	Ridgway	644	47
37	St. Marys	559	49
39	Turtle Creek	15, 300	119
41	Uniontown	1, 930	34
42	Washington	1, 540	139
	WEST VIRGINIA		
	Local protection projects		
11	Wheeling-Benwood	27, 000	275
12	Williamson	723	73
	Regional totals:		
	Local protection projects	128, 285	----------
	Reservoir projects	157, 920	----------
	All projects	286, 205	2, 489
	TENNESSEE BASIN		
	ALABAMA		
	Local protection projects		
1	Paint Rock River	770	109
	Regional totals:		
	Local protection projects	770	----------
	Reservoir projects	0	----------
	All projects	770	109
	UPPER MISSISSIPPI		
	ILLINOIS		
	Local protection projects		
57	Alton	4, 970	221
59	Campbells Island	512	60
61	Levee districts 3, 4, 8, 10, and 13, Kaskaskia River	7, 590	23
62	Henderson County Drainage District No. 1	1, 260	3
63	Henderson County Drainage District No. 2	930	2
64	Henderson River, Cedar Creek unit	930	10
65	Indian Grave Drainage District	5, 700	14
71	Lower Rock River levees	8, 300	40
72	New Athens	1, 680	2
77	Levees, Cowden to Vandalia (6 districts)	5, 453	26
78	Sny Island Levee Drainage District	8, 880	4
79	South Quincy Drainage and Levee District	1, 160	3
80	Subdistrict 1 of Drainage Union 1 and Bay Island	14, 400	59
	Reservoir projects		
76	Shelbyville	18, 500	147

PART III—PROJECTS AUTHORIZED BUT NOT YET UNDER CONSTRUCTION—Continued

[Thousands of dollars]

Map No.	Project designation	Total estimated first cost	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	UPPER MISSISSIPPI—Continued		
	IOWA		
	Local protection projects		
15	Des Moines	975	5
17	Green Bay Levee and Drainage District No. 2	1,570	75
18	Iowa River—Flint Creek Levee District No. 16	8,350	320
	Reservoir projects		
20	Saylorsville	49,300	280
	MINNESOTA		
	Local protection projects		
7	Mankato and North Mankato	2,250	160
10	Rushford	971	25
8	St. Paul and South St. Paul	7,070	440
9	Winona	1,970	38
	MISSOURI		
	Local protection projects		
20	Marion County Drainage District	1,250	75
21	South River Drainage District	2,030	4
	Reservoir projects		
18	Joanna	56,000	293
	WISCONSIN		
	Local protection projects		
3	Eau Galle River (includes Spring Valley Reservoir)	7,740	153
	Regional totals:		
	Local protection projects	85,941	
	Reservoir projects	123,800	
	All projects	209,741	2,482
	GREAT LAKES		
	ILLINOIS		
	Local protection projects		
70	Little Calumet River	751	69
	MICHIGAN		
	Local protection projects		
5	Kalamazoo	6,450	34
6	Lansing	11,600	51
7	Saginaw	20,000	323
	NEW YORK		
	Local protection projects		
33	Hammondsport	938	21
35	Ithaca (active unit only)	496	10
38	Owasco outlet at Auburn	373	17
39	Rome	380	7
	OHIO		
	Local protection projects		
22	Reno Beach—Howard Farms	677	6
	WISCONSIN		
	Local protection projects		
1	Mellen on Bad River	469	42
2	Odanah on Bad River	532	49
	Regional totals:		
	Local protection projects	42,666	
	Reservoir projects	0	
	All projects	42,666	629
	A. PROJECTS WITHOUT POWER—Continued		
	RED RIVER OF THE NORTH		
	None.		
	MISSOURI BASIN		
	IOWA		
	Local protection projects		
16	Floyd River	10,400	289
	Reservoir projects		
19	Rathbun	21,000	86
	KANSAS		
	Local protection projects		
21	Frankfort	1,130	60
24	Lawrence	3,150	7
26	Marysville	411	26
28	Merriam	490	1
30	Osawatomie	865	6
	Reservoir projects		
20	Fort Scott	17,700	12
22	Garnett	16,100	17
23	Hillsdale	9,800	5
27	Melvern	21,000	20
29	Milford	60,600	522
31	Perry	19,300	310
	MISSOURI		
17	Hackleman Corner	17,300	7
19	Kaysinger Bluff	106,000	268
	MONTANA		
	Local protection projects		
5	Billings	4,460	88
7	Great Falls	1,830	30
8	Miles City	1,600	11
	NEBRASKA		
	Local protection projects		
9	Beatrice	646	1
11	Shell Creek	2,400	35
	Reservoir projects		
10	Salt Creek system (12 reservoirs plus channel improvement).	17,200	158
	NORTH DAKOTA		
	Local protection projects		
6	Mott	540	30
	WYOMING		
	Local protection projects		
4	Buffalo	795	8
5	Dayton	158	3
	Regional totals:		
	Local protection projects	28,875	
	Reservoir projects	306,000	
	All projects	334,875	2,000
	COLORADO BASIN		
	ARIZONA		
	Local protection projects		
5	Gila River Channel improvement	1,700	189
6	Tucson Diversion Channel	4,740	111
	Reservoir projects		
4	Alamo	10,800	350
	Regional totals:		
	Local protection projects	6,440	
	Reservoir projects	10,800	
	All projects	17,240	650

See footnotes at end of table, p. 75.

PART III—PROJECTS AUTHORIZED BUT NOT YET UNDER CONSTRUCTION—Continued

[Thousands of dollars]

Map No.	Project designation	Total estimated first cost	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	GREAT BASIN		
	UTAH		
	Local protection projects		
3	Spanish Fork River	442	49
4	Weber River (Morgan to Ogden)	728	40
	Regional totals:		
	Local protection projects	1,170	----------
	Reservoir projects	0	----------
	All projects	1,170	89
	CENTRAL VALLEY OF CALIFORNIA		
	CALIFORNIA		
	Local protection projects		
43	Bear Creek	2,600	23
40	Sacramento River (Chico to Red Bluff)	1,850	8
	Reservoir projects		
38	New Melones	84,600	293
39	Oroville (non-Federal)[7]	50,000	104
42	Tuolumne Reservoirs (non-Federal)[7]	3,170	64
	Regional totals:		
	Local protection projects	4,450	----------
	Reservoir projects	137,770	----------
	All projects	142,220	492
	CALIFORNIA COASTAL BASINS		
	CALIFORNIA		
	Local protection projects		
41	Stewart Canyon Channel and Debris Basin.	1,670	150
	Reservoir projects		
37	Hodges Reservoir (non-Federal)[7]	2,410	98
	Regional totals:		
	Local protection projects	1,670	----------
	Reservoir projects	2,410	----------
	All projects	4,080	248
	COLUMBIA BASIN		
	IDAHO		
	Local protection projects		
12	Columbia Basin local protection, Boise Valley.[8]	650	100
13	Columbia Basin local protection, Camas Creek.[8]	885	16
14	Columbia Basin local protection, Heise-Roberts extension.[8]	5,980	36
15	Columbia Basin local protection, Weiser River [8]	3,100	94
	MONTANA		
	Local protection projects		
6	Clark Fork at Missoula [8]	527	22
	OREGON		
	Local protection projects		
52	Columbia Basin local protection, Grande Ronde River [8]	8,470	134
53	Columbia Basin local protection, John Day River [8].	659	25
56	Lower Columbia bank protection	8,600	65
57	Lower Columbia River, improvement of existing works, Beaver Drainage District.	600	59
58	Lower Columbia River, improvement of existing works, Clatskanie Drainage District	177	1
59	Lower Columbia River, improvement of existing works, Deer Island Drainage District	515	1
60	Lower Columbia River, improvement of existing works, Magruder Drainage District	75	2
	A. PROJECTS WITHOUT POWER—Continued		
	COLUMBIA BASIN—Continued		
	OREGON—continued		
	Local protection projects—Continued		
61	Lower Columbia River, improvement of existing works, Peninsula No. 1 Drainage District	1,310	68
62	Lower Columbia River, improvement of existing works, Peninsula No. 2 Drainage District	807	55
63	Lower Columbia River, improvement of existing works, Ranier Drainage District.	612	44
65	Lower Columbia River, improvement of existing works, Scappoose Drainage District	909	4
64	Lower Columbia River, improvement of existing works, Sauvie Island Drainage District	460	65
66	Lower Columbia River, levees at new locations, Clatskanie River	185	2
67	Lower Columbia River, levees at new locations, Hayden Island	606	2
68	Pilot Rock	322	8
69	Pudding River	7,190	8
70	Willamette River Basin, Linn County	771	3
71	Willamette River Basin, Bear Creek	285	1
72	Willamette River Basin, Coyote and Spencer Creeks	1,370	30
73	Willamette River Basin, Flat Creek.	1,400	5
74	Willamette River Basin, Shelton ditch	1,800	6
75	Willamette RiverBasin, West Muddy and Marys Rivers	2,960	10
76	Willamette River Basin, channel clearing and snagging	3,030	15
	Reservoir projects		
51	Blue River	16,900	539
54	Fall Creek	23,700	600
55	Holley	13,300	380
	WASHINGTON		
	Local protection projects		
21	Colfax	3,200	261
22	Columbia Basin local protection, lower Cowlitz [8]	132	14
25	Columbia Basin local protection, Okanogan River [8]	200	11
23	Columbia Basin local protection, Palouse Rivtr [8]	663	2
24	Columbia Basin local protection, Yakima River [8]	1,340	25
26	Dayton	739	20
27	Lower Columbia River, improvement of existing works, Consolidated No. 1 Drainage District	1,570	19
28	Lower Columbia River, improvement of existing works, Consolidated No. 2 Drain-age District	1,370	11
29	Lower Columbia River, improvement of existing works, Cowlitz County No. 2 Drainage District	359	6
30	Lower Columbia River, improvement of existing works, Cowlitz County No. 13 Drainage District	85	6
31	Lower Columbia River, improvement of existing works, Cowlitz County No. 15 Drainage District	239	1
32	Lower Columbia River, improvement of existing works, Consolidated No. 1 Drainage District	1,390	110
33	Lower Columbia River, improvement of existing works, Wahkiakum County Drainage District No. 4.	419	4
34	Lower Columbia River, levees at new locations, Kalama River	880	2
36	LowerColumbia River, levees at new locations, Vancouver Lake	4,100	4
35	Lower Columbia River, levees at new locations, Washougal	1,600	75
37	Pullman	1,970	53
	Regional totals:		
	Local protection projects	74,331	----------
	Reservoir projects	53,900	----------
	All projects	128,231	3,024

See footnotes at end of table, p. 75.

PART III—PROJECTS AUTHORIZED BUT NOT YET UNDER CONSTRUCTION—Continued

[Thousands of dollars]

Map No.	Project designation	Total estimated first cost	Appropriations through June 30, 1960
	A. PROJECTS WITHOUT POWER—Continued		
	NORTH PACIFIC COASTAL BASINS		
	WASHINGTON		
	Local protection projects		
38	Raymond	482	29
39	Sammamish River	1,120	22
	Regional totals:		
	Local protection projects	1,602	
	Reservoir projects	0	
	All projects	1,602	51
	ALASKA BASINS		
	ALASKA		
	Local protection projects		
4	Fairbanks	10,800	60
5	Skagway	995	23
6	Talkeetna	80	4
	Regional totals:		
	Local protection projects	11,875	
	Reservoir projects	0	
	All projects	11,875	87
	HAWAII BASINS		
	HAWAII		
	Local protection projects		
2	K ainui	1,090	84
3	W ioa Stream	510	42
	Regional totals:		
	Local protection projects	1,600	
	Reservoir projects	0	
	All projects	1,600	126
	B. PROJECTS WITH POWER		
	NEW ENGLAND		
	None.		
	MIDDLE ATLANTIC		
	None.		
	SOUTH ATLANTIC AND EAST GULF		
	None.		
	LOWER MISSISSIPPI		
	ARKANSAS		
	De Gray (total cost, $33,700)	8,112	75
	Regional total	8,112	75
	SOUTHWEST AND WEST GULF		
	None.		
	ARKANSAS, WHITE, RED BASINS		
	None.		
	B. PROJECTS WITH POWER—Con.		
	OHIO BASIN		
	KENTUCKY		
	Booneville (total cost, $22,000)	13,385	12
	Regional total	13,385	12
	TENNESSEE BASIN		
	None.		
	UPPER MISSISSIPPI		
	None.		
	GREAT LAKES		
	None.		
	RED RIVER OF THE NORTH		
	None.		
	MISSOURI BASIN		
	MISSOURI		
	Stockton (total cost, $43,000)	36,278	238
	Regional total	36,278	238
	COLORADO BASIN		
	None.		
	GREAT BASIN		
	None.		
	CENTRAL VALLEY OF CALIFORNIA		
	None.		
	CALIFORNIA COAST BASINS		
	None.		
	COLUMBIA BASIN		
	MONTANA		
	Libby (total cost, $327,000)	95,909	181
	OREGON		
	Green Peter (total cost, $64,000)	29,903	516
	Regional total	125,812	697
	NORTH PACIFIC COASTAL BASINS		
	None.		
	ALASKA BASINS		
	None.		
	HAWAII BASINS		
	None.		
	PART III SUMMARY		
	A. WITHOUT POWER		
	Local protection projects	497,004	10,078
	Reservoir projects	1,397,030	10,677
	All projects	1,894,034	20,755
	B. WITH POWER		
	All projects	183,587	1,022
	Total, projects authorized but construction not started	2,077,621	21,777

See footnotes at end of table, p. 75.

Part IV—Small Flood Control Projects Not Individually Authorized [8]

[Includes projects completed or under construction, and also projects for which construction plans are being prepared, with latter indicated by asterisk*]

[Thousands of dollars]

Project designation	Total first cost flood control
A. PROJECTS WITHOUT POWER	
New England	
CONNECTICUT	
Local protection projects	
Norwalk River at Norwalk	52.2
East Branch Naugatuck River at Torrington	355.0
Naugatuck at Waterbury and Watertown*	160.0
West Branch Naugatuck River at Torrington	393.0
Byram River at Pemberwick	394.0
MASSACHUSETTS	
Local protection projects	
Ware River at Ware	400.0
NEW HAMPSHIRE	
Local protection projects	
Cocheco River at Farmington	87.5
Cocheco River at Farmington	41.5
Regional totals:	
Local protection projects	1,883.2
Reservoir projects	0
All projects	1,883.2
Middle Atlantic	
MARYLAND	
Local protection projects	
North Branch Potomac River at Kitzmiller*	280.0
NEW YORK	
Local protection projects	
Chenango River at Norwich	94.5
Birdsall Creek at Greene	37.0
Owego River at Owego	40.0
North Branch Susquehanna River at Conklin-Kirkwood	71.0
Wappinger Creek at Pleasant Valley	139.0
Newton Creek at Bainbridge	355.0
PENNSYLVANIA	
Local protection projects	
Chester River at Chester	183.3
VIRGINIA	
Local protection projects	
At Bridgewater	136.5
Regional totals:	
Local protection projects	1,336.3
Reservoir projects	0
All projects	1,336.3
South Atlantic and East Gulf	
ALABAMA	
Local protection projects	
Black Creek at Gadsden	125.4
FLORIDA	
Local protection projects	
Jackson County	106.0
Archer Creek in Dade County	144.0
GEORGIA	
Local protection projects	
Beaver Creek at Montezuma	150.0
Town Creek at Americus*	162.0
A. PROJECTS WITHOUT POWER—Continued	
South Atlantic and East Gulf—Continued	
MISSISSIPPI	
Local protection projects	
Sowaskee Creek at Meridian	143.0
NORTH CAROLINA	
Local protection projects	
Core Creek in Craven County*	282.0
Ellerbe Creek at Durham*	218.0
Regional totals:	
Local protection projects	1,330.4
Reservoir projects	0
All projects	1,330.4
Lower Mississippi	
TENNESSEE	
Local protection projects	
Nixon Creek	62.8
North Branch of Forked Deer River at Dyersberg	204.5
Regional totals:	
Local protection projects	267.3
Reservoir projects	0
All projects	267.3
Southwest and West Gulf	
LOUISIANA	
Local protection projects	
Bayou Choupique	129.9
Black Bayou at Pine Island*	326.0
TEXAS	
Local protection projects	
Bonita Creek at Pleasanton	123.9
San Diego Creek at Alice	145.6
Tranquitas Creek at Kingsville	148.0
Clodine ditch, Buffalo Bayou	13.0
Colorado River at Matagorda*	325.0
Regional totals:	
Local protection projects	1,211.4
Reservoir projects	0
All projects	1,211.4
Arkansas, White, and Red Basins	
COLORADO	
Reservoir projects	
Pinon Canyon Dam	130.4
LOUISIANA	
Local protection projects	
Bayou Rapides	95.2
Regional totals:	
Local protection projects	130.4
Reservoir projects	95.2
All projects	225.6
Ohio Basin	
INDIANA	
Local protection projects	
Grassy Creek in Jackson County	70.
Salamonie River at Portland*	3 20.

See footnotes at end of table, p. 75.

PART IV—SMALL FLOOD CONTROL PROJECTS NOT INDIVIDUALLY AUTHORIZED *—Continued

[Thousands of dollars]

Project designation	Total first cost flood control
A. PROJECTS WITHOUT POWER—Continued	
OHIO BASIN—Continued	
KENTUCKY	
Local protection projects	
Levisa Fork at Prestonburg	380.0
Tygarts Creek at Olive Hill	397.0
MARYLAND	
Local protection projects	
Bear Creek at Friendsville	41.5
OHIO	
Local protection projects	
Yellow Creek at Amsterdam	180.0
Cherry Valley Run at Leetonia	80.0
PENNSYLVANIA	
Local protection projects	
Granville in Washington County	75.9
Raccoon Creek at Burgettstown	83.1
Raccoon Creek at Slovan	57.8
Little Conemaugh River at Wilmore	114.7
Oil Creek at Oil City	51.0
Stump Creek at Sykesville*	183.0
Bull Creek at Tarentum*	137.0
Regional totals:	
Local protection projects	2,171.3
Reservoir projects	0
All projects	2,171.3
TENNESSEE BASIN	
None.	
UPPER MISSISSIPPI	
ILLINOIS	
Local protection projects	
Kishwaukee River at DeKalb	123.5
MINNESOTA	
Local protection projects	
Okabena Creek at Worthington	72.4
Redwood River at Marshall	225.0
Regional totals:	
Local protection projects	420.9
Reservoir projects	0
All projects	420.9
GREAT LAKES	
NEW YORK	
Local protection projects	
Marsh Creek at Geneva	223.5
OHIO	
Local protection projects	
Camp Perry	150.0
WISCONSIN	
Local protection projects	
Oconto River at Oconto	149.0
Regional totals:	
Local protection projects	522.5
Reservoir projects	0
All projects	522.5
A. PROJECTS WITHOUT POWER—Continued	
RED RIVER OF THE NORTH	
None.	
MISSOURI BASIN	
COLORADO	
Reservoir projects	
Dam at Aurora	150.0
KANSAS	
Local protection projects	
Stonehouse Creek	142.0
Salt Creek at Bernard	144.5
MONTANA	
Local protection projects	
Shields River at Clyde Park	25.8
Yellowstone River at West Glendive	182.4
NEBRASKA	
Local protection projects	
Big Blue River at Seward	126.9
NORTH DAKOTA	
Local protection projects	
Buffalo Creek at Scranton	104.4
SOUTH DAKOTA	
Local protection projects	
Spring Creek at Herried	45.8
Reservoir projects	
Red Dale Gulch at Rapid City	142.2
Regional totals:	
Local protection projects	921.8
Reservoir projects	142.2
All projects	1,064.0
GREAT BASIN	
UTAH	
Reservoir projects	
Big Wash at Milford*	380.0
Regional totals:	
Local protection projects	0
Reservoir projects	380.0
All projects	380.0
CENTRAL VALLEY OF CALIFORNIA	
CALIFORNIA	
Local protection projects	
Rheem Creek, Contra Costa County	240.0
Regional totals:	
Local protection projects	240.0
Reservoir projects	0
All projects	240.0
CALIFORNIA COASTAL BASINS	
CALIFORNIA	
Local protection projects	
Coyote Creek, Marin County*	400.0
City Creek, San Bernardino County	345.0
Regional totals:	
Local protection projects	745.0
Reservoir projects	0
All projects	745.0

See footnotes at end of table, p. 75.

PART IV—SMALL FLOOD CONTROL PROJECTS NOT INDIVIDUALLY AUTHORIZED [9]—Continued

[Thousands of dollars]

Project designation	Total first cost flood control
A. PROJECTS WITHOUT POWER—Continued	
COLUMBIA BASIN	
IDAHO	
Local protection projects	
Graves Creek at Cottonwood	75.5
Shoshone River at Gooding	59.6
Tomanovich-Salmon City	99.4
OREGON	
Local protection projects	
Clackamas River below Carver	46.7
Molalla River at Ressel	38.4
Molalla River at Milk Creek	55.0
Umatilla River near Pendleton	275.0
Salmon Creek at Oakridge	387.0
WASHINGTON	
Local protection projects	
Dry Creek and Walla Walla River	264.0
Zintel Canyon at Kennewick[7]	390.0
Regional totals:	
Local protection projects	1,690.6
Reservoir projects	0
All projects	1,690.6
NORTH PACIFIC COASTAL BASINS	
OREGON	
Local protection projects	
Catching Inlet Drainage District, Coos River	185.0
Stilwell Drainage District, Tillamook Bay	186.0
WASHINGTON	
Local protection projects	
American Lake near Fort Lewis	60.5
Regional totals:	
Local protection projects	431.5
Reservoir projects	0
All projects	431.5
HAWAII BASINS	
Local protection projects	
Kaunakakai Stream at Molokai	73.8
Regional totals:	
Local protection projects	73.8
Reservoir projects	0
All projects	73.8

Project designation	Total first cost flood control
PART IV—SUMMARY	
A. WITHOUT POWER	
Local protection projects	13,191
Reservoir projects	803
All projects	13,994
B. WITH POWER	
None.	
Total, projects not individually authorized	13,994

SUMMARY OF PARTS I, II, AND III—ENTIRE ACTIVE PROGRAM OF INDIVIDUALLY AUTHORIZED PROJECTS

[Thousands of dollars]

	First cost	Appropriations through June 30, 1960
A. WITHOUT POWER		
Local protection projects	3,268,960	1,838,909
Reservoir projects	3,572,090	1,408,293
All projects	6,841,050	3,247,202
B. WITH POWER		
All projects	935,945	563,509
Total	7,776,995	3,810,711

SUMMARY OF ALL PROJECTS SHOWN IN SUPPLEMENT C (PARTS I, II, III, AND IV)

[Thousands of dollars]

	First cost	Appropriations through June 30, 1960
A. WITHOUT POWER		
Local protection projects	3,282,151	1,852,100
Reservoir projects	3,572,893	1,409,096
All projects	6,855,044	3,261,196
B. WITH POWER		
All projects	935,945	563,509
Total	7,790,989	3,824,705

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[1] Includes some funds appropriated for relief of unemployment during the depression of the 1930's (PWA and ERA funds).

[2] In addition to the amount shown some unemployment relief funds were spent on this project.

[3] This project covers only the modification of a previously constructed project, and the cost shown is the cost of the modification only.

[4] This project was not constructed by the Corps of Engineers, but through the Corps the Federal Government contributed the amount shown on account of the flood control benefits creditable to the project.

[5] The cost shown is that required to complete the first phase of the Missouri River agricultural levees project. Studies are now (1960) underway to establish the scope of the next phase. As the estimated cost of the next phase is not known it does not appear in supplement C.

[6] Mississippi River and tributaries project is treated as a single project. It encompasses the main line levees, 5 reservoirs and certain other works.

[7] This project to be constructed by non-Federal interests with the Federal Government contributing the amount indicated on account of the flood control benefits creditable to the project.

[8] These projects are conditionally authorized.

[9] Projects constructed under authority of Public Law 685, 84th Cong., and earlier legislation amended by Public Law 685.

SUPPLEMENT D

BREAKDOWN OF APPROPRIATIONS, 1824-1960, BY FUNCTIONS AND BY STATES

MAY 23, 1960.

Hon. ROBERT S. KERR,
Chairman, Select Committee on National Water Resources.

DEAR MR. CHAIRMAN: This is in reply to your letter of December 2, 1959, requesting a breakdown, by States and by decades through June 30, 1959, of the total appropriations for the flood control and navigation programs of the Corps of Engineers.

Enclosure 1 presents, in table I, the appropriations for civil works activities of the Corps of Engineers, broken down generally according to appropriation titles currently used for that program; and, in table II, the approximate distribution of these funds to the major functions of navigation and flood control.

It is not practicable to break down our historical records of appropriations to show a State distribution by decades. However, enclosure 2 gives an approximate distribution of the total appropriations to the various States involved. The total appropriations for projects located in more than one State are distributed to the States involved, as equitably as possible from available records.

I trust this information will be helpful to your committee.

Sincerely yours,

E. C. ITSCHNER,
Lieutenant General, U.S. Army,
Chief of Engineers.

TABLE I.—*Appropriations to the Corps of Engineers for civil works activities* [1]

[Millions of dollars]

Fiscal years	Total	Navigation projects			Flood control projects			Multiple-purpose projects including power			Beach erosion control projects	Surveys, administration and miscellaneous
		Subtotal	New work	Maintenance	Subtotal	New work	Maintenance	Subtotal	New work	Maintenance		
1824-99	351.7	346.5	231.0	115.5								5.2
1900-1909	234.4	232.8	155.2	77.6								1.6
1910-19	412.6	377.5	251.7	125.8	13.0	9.7	3.3	18.2	18.2			3.9
1920-29	609.3	462.9	268.7	194.2	108.6	80.8	27.8	27.4	26.5	0.9		10.4
1930-39	1,771.4	994.9	705.7	289.2	531.9	488.6	43.3	194.2	192.8	1.4		50.4
1940-49	2,746.2	830.5	347.2	483.3	1,295.0	1,083.9	211.1	540.4	528.1	12.3	0.3	80.0
1950-59	6,015.5	1,511.7	807.2	704.5	2,061.2	1,735.2	326.0	2,267.6	2,180.4	87.2	5.7	169.4
1960	869.9	292.0	209.0	83.0	317.6	286.4	31.2	233.6	215.2	18.4	.9	25.7
1824-1960	13,011.0	5,048.8	2,975.7	2,073.1	4,327.3	3,684.6	642.7	3,281.4	3,161.2	120.2	6.9	346.6

[1] Includes about $½ billion for superseded and abandoned work and for other items not ordinarily included in the existing authorized civil works program.

TABLE II.—*Civil works appropriations allocable to the navigation and flood control functions*

[Millions of dollars]

Fiscal years	Navigation				Flood control			
	New work	Maintenance	Surveys, administration and miscellaneous	Total	New work	Maintenance	Surveys, administration and miscellaneous	Total
1824-99	231.0	115.5	5.2	351.7				
1900-1909	155.2	77.6	1.6	234.4				
1910-19	253.9	127.4	3.9	385.2	7.5	1.7		9.2
1920-29	286.1	207.5	8.8	502.4	63.4	14.5	1.6	79.5
1930-39	814.7	307.8	36.9	1,159.4	438.3	24.8	13.5	476.6
1940-49	440.7	533.5	41.4	1,015.6	1,176.9	164.0	38.7	1,379.6
1950-59	1,160.9	780.2	39.6	1,980.7	1,964.7	266.7	64.5	2,295.9
1960	258.3	92.1	5.9	356.3	308.0	25.2	11.1	344.3
1824-1960	3,600.8	2,241.6	143.3	5,985.7	3,958.8	496.9	129.4	4,585.1

TABLE III.—*Geographical distribution, by States, of total appropriations through fiscal year 1960 for new work on existing projects under the authorized civil works program of the Corps of Engineers*

[Millions of dollars]

State	Navigation projects	Flood control projects	Multiple-purpose projects including power	Beach erosion control projects	Total
Alabama	83.4	0.8	17.7	....	101.9
Alaska	14.5	1.3	....	....	15.8
Arizona	(.01)	21.3	....	....	21.3
Arkansas	35.3	277.2	150.1	....	462.6
California	120.5	501.2	63.0	0.1	684.8
Colorado	....	31.8	....	....	31.8
Connecticut	13.8	31.5	....	1.1	46.4
Delaware	30.0	....	....	....	30.0
Florida	87.2	58.9	23.2	....	169.3
Georgia	12.0	4.8	183.2	....	200.0
Hawaii	24.1	.4	....	....	24.5
Idaho	.2	20.8	32.0	....	53.0
Illinois	214.1	120.8	....	.3	335.2
Indiana	48.2	43.8	....	....	92.0
Iowa	92.8	51.1	....	....	143.9
Kansas	29.5	174.0	....	....	203.5
Kentucky	115.9	143.5	95.5	....	354.9
Louisiana	115.6	451.8	....	....	567.4
Maine	12.2	....	....	....	12.2
Maryland	20.5	12.3	....	....	32.8
Massachusetts	79.6	64.8	....	.2	144.6
Michigan	193.2	7.3	10.2	....	210.7
Minnesota	55.5	9.6	....	....	65.1
Mississippi	8.9	280.6	....	1.1	290.6
Missouri	202.2	123.4	85.0	....	410.6
Montana	....	2.0	152.2	....	154.2
Nebraska	52.9	39.8	47.4	....	140.1
Nevada	....	2.0	....	....	2.0
New Hampshire	1.3	25.7	....	0.1	27.1
New Jersey	91.9	.3	....	1.0	93.2
New Mexico	....	30.2	....	....	30.2
New York	181.8	92.7	....	1.0	275.5
North Carolina	24.4	1.3	43.0	....	68.7
North Dakota	....	17.4	284.2	....	301.6
Ohio	141.5	103.0	....	....	244.5
Oklahoma	6.6	123.3	117.7	....	247.6
Oregon	34.9	41.2	527.8	....	603.9
Pennsylvania	104.5	184.1	....	.8	289.4
Rhode Island	7.7	4.8	....	(.04)	12.5
South Carolina	19.7	....	66.2	....	85.9
South Dakota	....	18.0	395.8	....	413.8
Tennessee	6.8	75.8	163.6	....	246.2
Texas	120.7	178.1	88.7	....	387.5
Utah	....	2.5	....	....	2.5
Vermont	.9	35.5	....	....	36.4
Virginia	49.8	8.7	56.3	.2	115.0
Washington	41.1	51.8	554.8	....	647.7
West Virginia	99.6	84.9	....	....	184.5
Wisconsin	14.1	.1	....	....	14.2
Wyoming	....	2.7	....	....	2.7
District of Columbia	2.4	3.0	....	....	5.4
Total	2,611.8	3,561.9	3,157.6	5.9	9,337.2

NOTE 1. This tabulation is limited to appropriations for new work under existing projects specifically authorized by Congress. It excludes appropriations for superseded and abandoned projects, for flood control projects not specifically authorized by Congress but accomplished under special continuing authorities (snagging and clearing, emergency bank protection, and other small local protection projects), and for recreational facilities on previously completed projects. Accordingly, the total shown above is almost half a billion dollars less than the total appropriations for new work shown under the various classifications in table I.

NOTE 2. The total appropriations shown above for "Flood control projects' include about $265 million under the "Flood control, Mississippi River and tributaries" project allocable to the navigation function. The total appropriations shown above for "Multiple-purpose projects including power" include about $343 million allocable to the navigation function and about $557 million allocable to the flood control function. Thus, of the total appropriations for new work under the authorized civil works program, as indicated above for the 50 States and the District of Columbia, about $3,220 million is allocable to navigation and about $3,854 million to flood control.

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